Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JANUARY, 1952

TECHNOLOGY DEPT.

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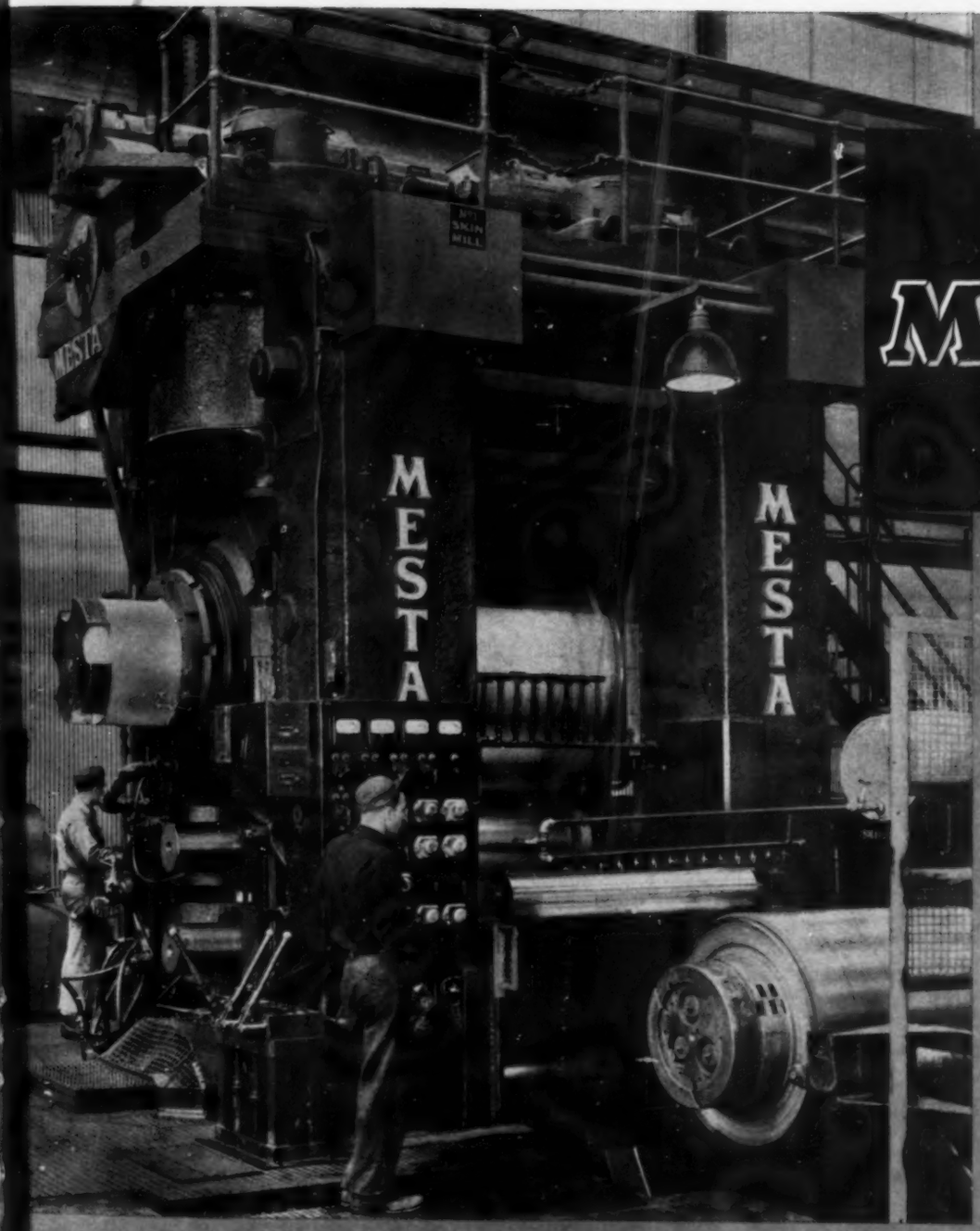


Mesta 56" Four-High Temper Mill

MESTA

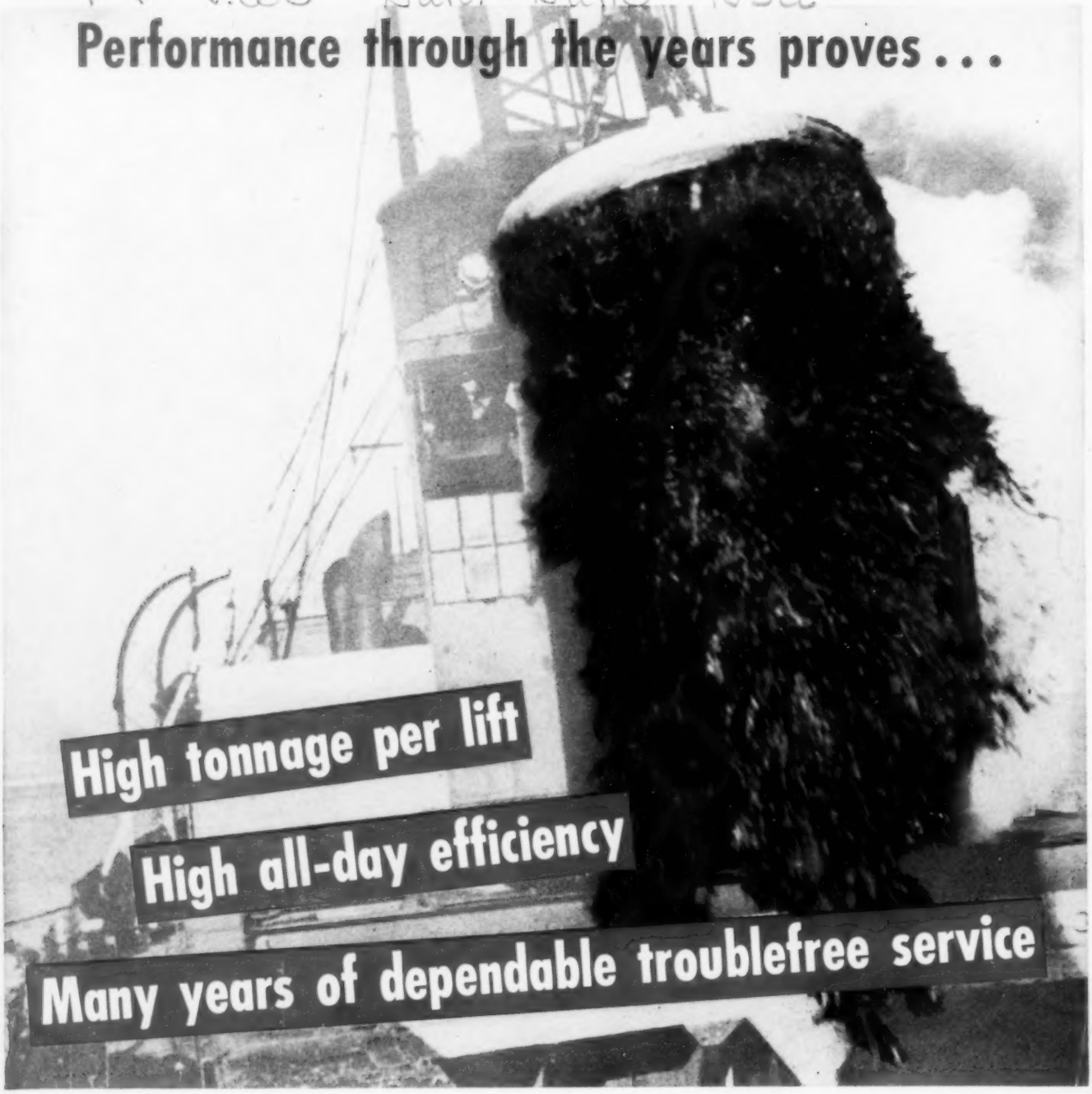
higher speed COLD MILLS

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY • PITTSBURGH, PA.

R v.29 Jan.-June 1952

Performance through the years proves . . .



The records of Cutler-Hammer magnets through almost 50 years of service—in steel mills, scrap yards, and foundries; on railroads, ships, and docks—tell more than words can do why these magnets have earned such an enviable reputation for rugged, dependable day-after-day performance with minimum out of service time.

The secret of any magnet's lifting power lies in its coil. The coil of every C-H Supermagnet, wound under tension, vacuum impregnated with a special compound, baked to form a solid mass, is sheathed in a welded sheet steel housing that makes coil moisture troubles a thing of the past. Dynamo steel body for greater lift, tough alloy pole shoes that resist wear and increase strength, double sealed water-tight terminal box, and a yoke design that keeps chains separate and prevents twisting for added chain life . . . these are features that have made Cutler-Hammer modern Supermagnets the choice wherever iron and steel are handled.

If you are a Cutler-Hammer magnet user you know these facts. If not, we suggest the only completely satisfactory way you can learn them—specify Cutler-Hammer magnets on your next order and compare the results. CUTLER-HAMMER, Inc., 1257 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
SUPERMAGNETS
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 1

Continental

MERCHANT-BAR MILL

Rolling Mill installations engineered complete

for steel, alloy and non-ferrous metals

BLOOMING MILLS
STRUCTURAL MILLS
RAIL MILLS
BILLET MILLS
ROD MILLS
BAR MILLS
MERCHANT MILLS

★ ★ ★

SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

★ ★ ★

Mills complete with Auxiliary Equipment

★ ★ ★

ROLL LATHES

★ ★ ★

SPECIAL MACHINERY

★ ★ ★

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

CHICAGO • PITTSBURGH

Plants at:
East Chicago, Ind.
Wheeling, W. Va.
Pittsburgh, Pa.

CONTINENTAL
Foundry & Machine
Company

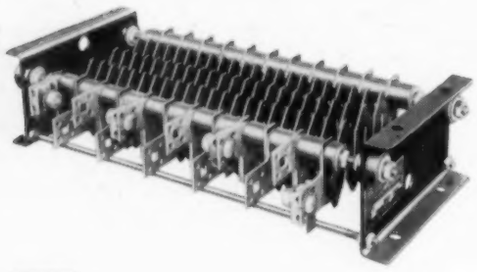
The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.

TAB • WELD

CONSTRUCTION does what clamping could not do

•

Stabilizes OHMIC VALUE independent of end clamping-nut pressure



▼

NO NUT TIGHTENING because burning does not occur

It's difficult to find "down-time" for servicing industrial equipment. Short lulls in production do not always permit time for a complete service job. Forgotten or unserviced items operate at lower efficiency—may eventually fail and require major repair or replacement.

When buying motor control resistors, do not overlook the low upkeep advantages of EC&M TAB-WELD Resistors. These plate resistors are off-set to bring grid-eyes into intimate contact and the tab-ends are welded. Tap-plates are also welded in place at convenient points. *No burning at grid-eyes or at tap-plates.* When replacing resistors or for new installations, specify EC&M Bulletin 942 TAB-WELD Plate Resistors.

LOWER UPKEEP saves the inital cost and more

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

ETABLISSEMENTS CHARLES COQUILLARD
ALUMINIUM MINCE
LAMINAGE BY TRANSFORMATION
HYDROPRESS, Inc.
570, Lexington Avenue 570
NEW YORK 22 NY
Gentlemen:
We ordered from you, in February 1948, an installation for the rolling of aluminum stripe and thin foil:
Width..... 1,000 m (40")
Thickness.... 9/1000 (.00035")
Weight..... 1,200 kg (2650 lbs.)
Speed..... 1,000 m/min. (3280 ft./min.)
We are pleased to advise you that this complex material, received in June 1950, was put into operation in November 1950, after having been erected by ourselves without great difficulty.
This material gives us entire satisfaction and its production will be four times greater than the estimated output guaranteed by your contract.
We authorise you to make use of this attestation.
Please accept, Gentleman, the expression of our kindest regards.
Le Directeur General
This material gives us entire satisfaction and its production will be four times greater than the estimated output guaranteed by your contract.

LOEWY HIGH SPEED ROLLING MILLS

FOR STRIP AND FOIL

- *speed more than 3000 FPM*
- *designed for one-man operation*
- *extremely sensitive tension & temperature control*

We were the first designers of High-Speed Foil Mills in 1945. Since then many details of our design have been greatly improved and tested in actual production.

We supply complete Rolling Mill Installations and the specialized Auxiliary Equipment that is indispensable for high-speed production of foil and other strip material to accurate gauge.

Four-High Cold Strip Mill For Roughing Aluminum Foil. A part of the High-Speed Cold Rolling Mill Installation for the production of aluminum foil 42" wide and .00025" thick supplied to Etablissements Charles Coquillard, France.

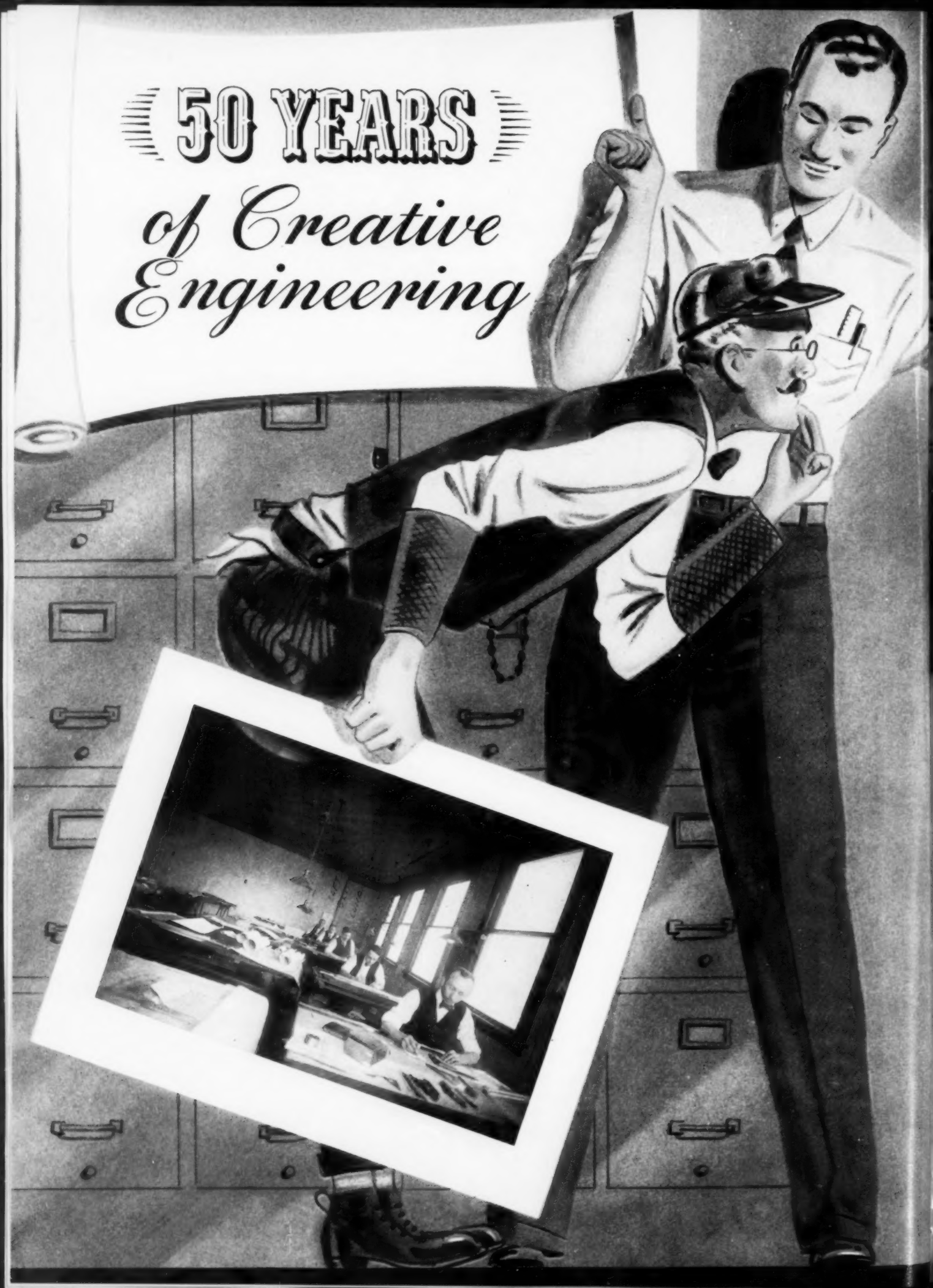
LOEWY ROLLING MILL DIVISION

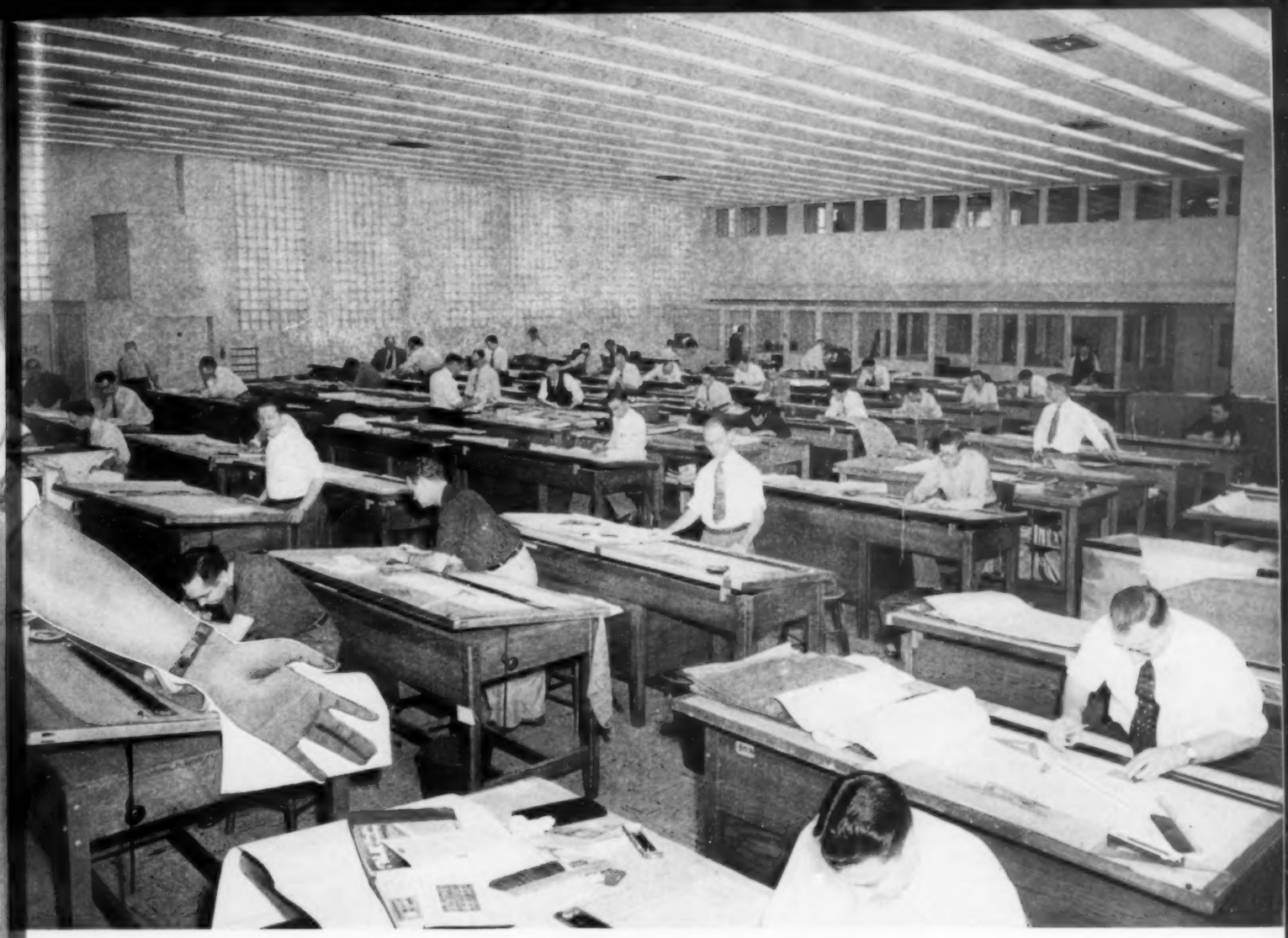
HYDROPRESS INC.

ROLLING MILLS AND ROLLING MILL EQUIPMENT

565-563 Lexington Avenue *General Electric Bldg. at 51st Street* **New York 22**

CHICAGO • DETROIT • SAN FRANCISCO • SEATTLE • WASHINGTON, D. C.


50 YEARS
of Creative
Engineering



Aetna points with pride to its many engineering achievements in the last 50 years.

The list is long.

But Aetna-Standard hesitates to claim any single development as its very own creation. Engineers of the various companies and industries have worked closely with Aetna's engineers in transforming dreams into reality . . . for example:

Continuous Tube Rolling Mill and the Stretch Reducing Mill.

Rotary Flying Hot Saw and 12-stand Forming and Welding Mill.

One-man Triple Drawbench and Hydraulic Squeeze Pointer.

Continuous Coating Lines and High Speed Shearing and Classifying Lines.

Automatic Synchronization for Wire Drawing.

An engineering firm, like Aetna-Standard, prospers and contributes to the degree in which that company recognizes a need and gains the cooperation of the industry. Without that cooperation, little could be accomplished.

So we prefer to shine the spotlight on our customers instead of ourselves as we look back over 50 years and ahead to the next 50.

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany—Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

Aetna-Standard

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio . Ellwood City, Pennsylvania

They did . . .

Weirton needed more production from this mill. The way to get it—a new drive.

what . . .

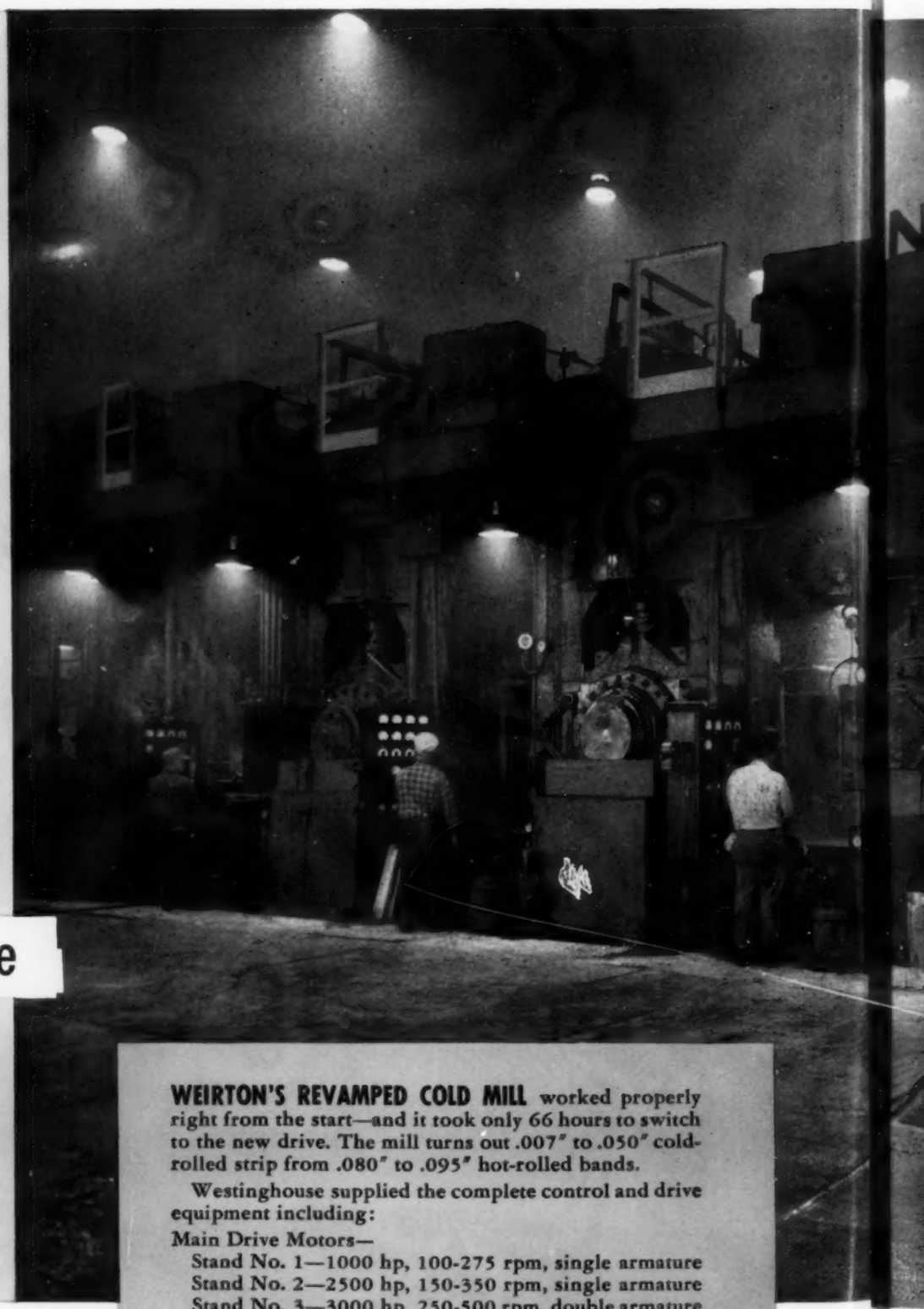
They called in Westinghouse to help engineer the drive. Based on our experience with similar installations, we attacked the problem *as a whole*—and helped them put together *a co-ordinated electrical system.*

you can do . . .

This experience and this method can be applied to *your* next project—whatever it is. Westinghouse can work with you on *all* your electrical needs.

to produce more

The result will be more production, lower costs, better operations—or a combination. Whether you need one motor, or a complex system, Westinghouse can come up with the answer.



WEIRTON'S REVAMPED COLD MILL worked properly right from the start—and it took only 66 hours to switch to the new drive. The mill turns out .007″ to .050″ cold-rolled strip from .080″ to .095″ hot-rolled bands.

Westinghouse supplied the complete control and drive equipment including:

Main Drive Motors—

Stand No. 1—1000 hp, 100-275 rpm, single armature
Stand No. 2—2500 hp, 150-350 rpm, single armature
Stand No. 3—3000 hp, 250-500 rpm, double armature
Stand No. 4—3000 hp, 312-625 rpm, double armature
Reel —600 hp, 180-720 rpm, double armature

Power for the drive motors is supplied by a new four-generator M-G set, along with one existing M-G set from the original drive. Each motor is fed by its own generator.

They sold the FIRST COIL they rolled on this revamped tandem mill!

Weirton Steel had Westinghouse build a complete new drive for this tandem cold strip mill—to boost the speed from 1500 to 3000 fpm. The mill was down only 66 hours for the change-over. And the first new coil they rolled was of salable quality!

PROBLEMS SOLVED AHEAD OF TIME

How were they able to do it in such a short time? It was based on previous Westinghouse strip mill experience. The operating and engineering problems were anticipated—and solved *ahead* of time.

TOTAL DOWNTIME FOR REVAMP: 66 HOURS

The new drive was built alongside the old one, according to an ingenious plan worked out by Weirton and Westinghouse engineers. They changed over while the mechanical equipment was being revamped. The mill was rolling 66 hours later—and it hasn't needed a major adjustment since then.

CALL WESTINGHOUSE EARLY ON EVERY JOB

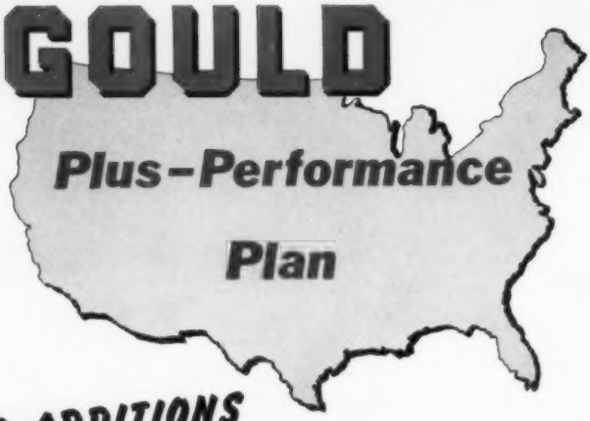
This is the kind of thinking Westinghouse applies to *all* steel mill electrical projects. Whatever your next job is—a main mill drive, the equipment for an electrical furnace, an auxiliary motor—call your Westinghouse office early in the planning stage. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94899

YOU CAN BE SURE... IF IT'S

Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY

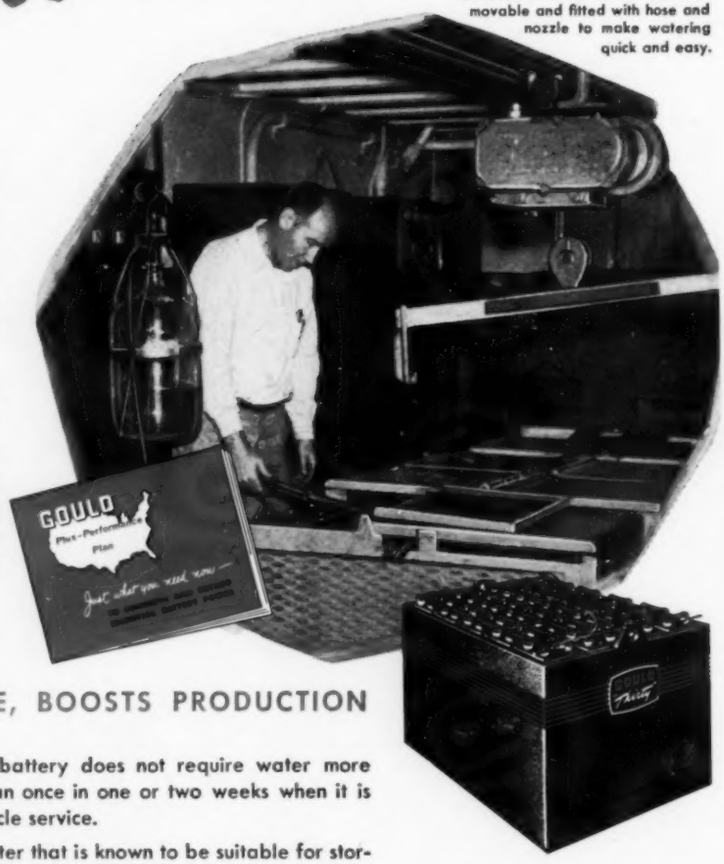
GOULD



REGULAR WATER ADDITIONS

ADD MONTHS TO BATTERY SERVICE!

Distilled water containers should be movable and fitted with hose and nozzle to make watering quick and easy.



The amount of water used by a battery indicates its general condition. That's why regular, systematic watering is so important to maximum battery service. The GOULD PLUS-PERFORMANCE PLAN gives you complete technical information, not only on how to establish a regular watering routine, but on practically every problem connected with storage battery use.

Comprising manuals, articles, specifications, bulletins, charts, graphs and forms, the GOULD PLUS-PERFORMANCE PLAN tells you how to select, charge and handle, maintain and determine the condition of your batteries. Use it consistently and you can improve your battery performance as much as 50%! All material is free. A request will bring descriptive booklet by return mail.

WATERING ROUTINE CUTS DOWN-TIME, BOOSTS PRODUCTION

Level of electrolyte should be maintained between low and high level points. The minimum low level point should be above the splash cover. Maximum high level point is just under the bottom of the vent-well in the cover.

It is normal for electrolyte level to decrease very gradually with use. Rapidity of decrease will depend upon how much charge it receives over and above what it requires. Under normal conditions, a battery does not require water more often than once in one or two weeks when it is in full cycle service.

Only water that is known to be suitable for storage batteries should be used. It should be pure and free from any contamination. Distilled water is recommended. Water should be kept in clean containers of glass, plastic or porcelain with cork, glass or rubber stoppers.

The GOULD "Thirty" with "Z" Plates—America's Finest Industrial Truck Battery

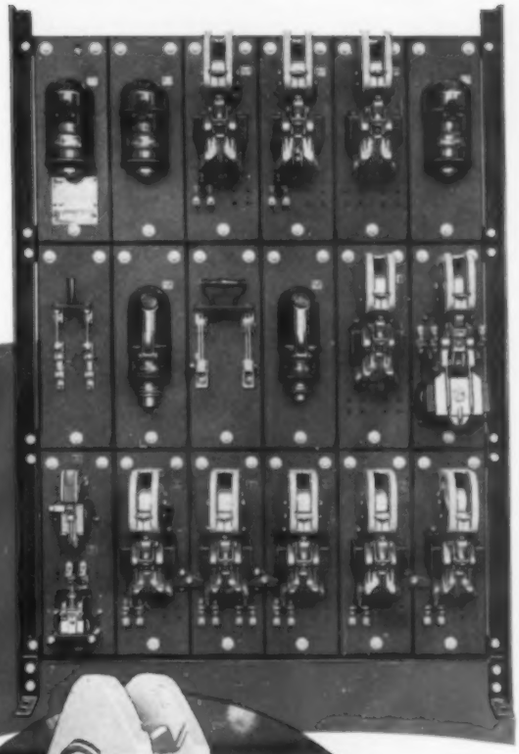
GOULD STORAGE BATTERIES

GOULD-NATIONAL BATTERIES, INC., TRENTON 7, NEW JERSEY

Always Use Gould-National Automobile and Truck Batteries

8 *Important Features of* **EC&M** *Magnetic Control*

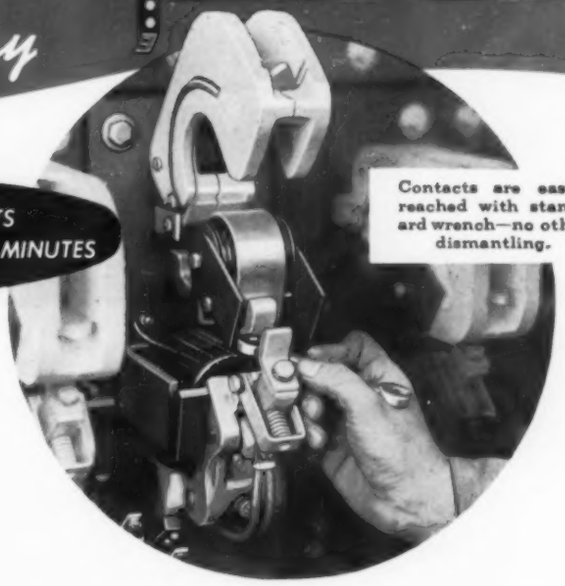
1 Time-Current Acceleration
2 Line-Arc Contactors
3 Wright Hoist Circuit
4 Tab-Weld Resistors
5 Cam Master Switches
6 Safer Electrical Interlocks
7 Bolted, Welded Frame
8 Quick Contact Renewing ✓



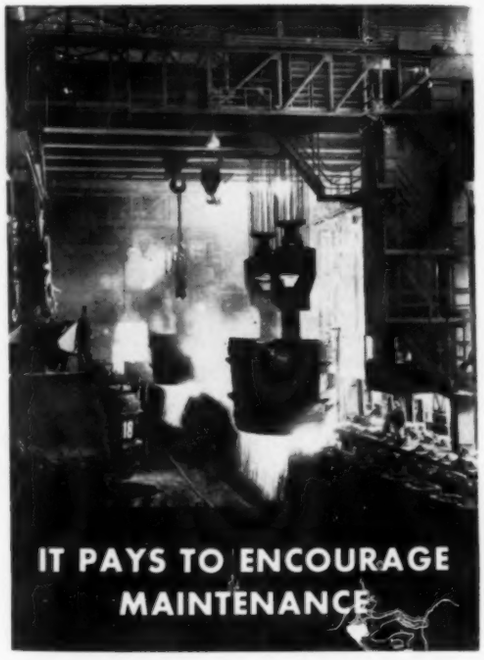
QUICK CONTACT RENEWING

makes maintenance easy

FRONT AND REAR CONTACTS REPLACED IN LESS THAN 2 MINUTES



Contacts are easily reached with standard wrench—no other dismantling.



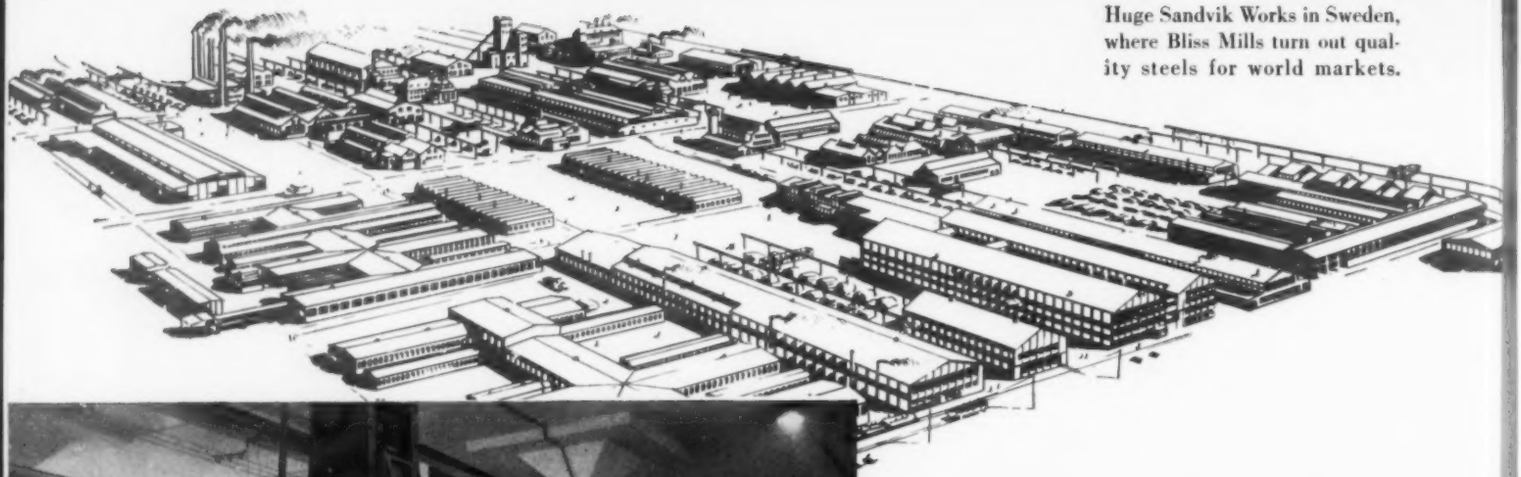
The EC&M *LINE-ARC* principle assures long life of contacts, but when needed, quick contact renewal is easily accomplished. Tests show the time for replacing stationary and movable contacts of EC&M *LINE-ARC* Contactors averages less than two minutes.

Note that a standard wrench may be used which gives good leverage for both loosening and tightening operations. There are no other contactor parts which must first be removed to make the contact tips accessible. EC&M Magnetic Control encourages good maintenance.

E&M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO



Huge Sandvik Works in Sweden, where Bliss Mills turn out quality steels for world markets.

Four-stand cold reduction mill, designed and built by E. W. Bliss Company for Sandvik, produces high-carbon and stainless strip.

Bliss mandrel-coiler for Sandvik's 300 mm. hot strip mill.

NEW BLISS MILLS PRODUCE MORE SPECIALTY STEELS FOR SANDVIK

When world-famous Sandvik Steel Works, Sandviken, Sweden, decided to increase production of its cold-rolled high-carbon and stainless steels, it naturally turned to Bliss. Bliss' experience in designing strip mills is demonstrated daily at leading steel plants all over the world.

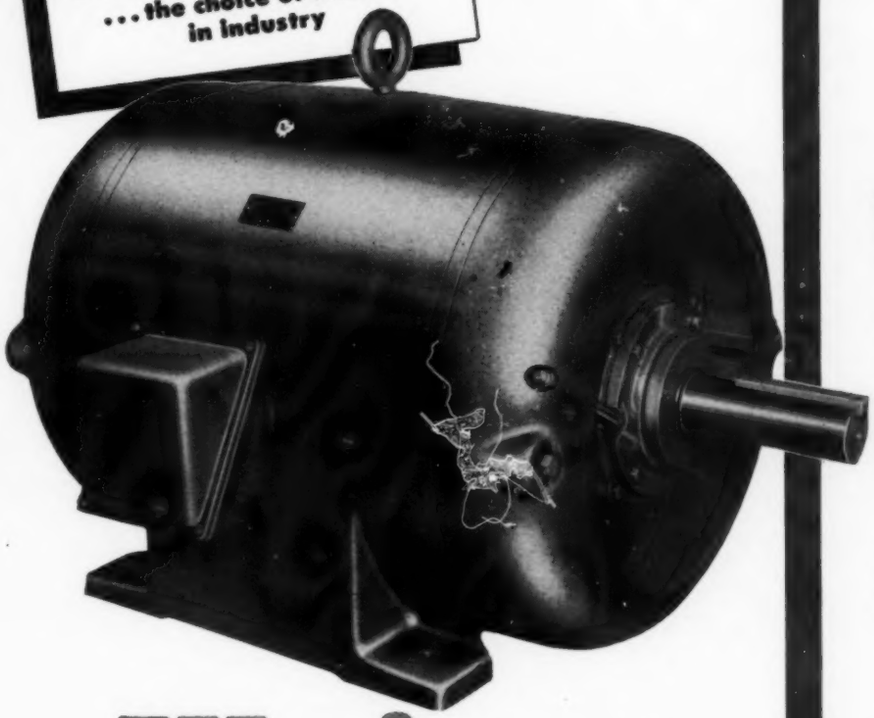
In creating a four-stand cold reduction mill Bliss supplied an installation with *capacity to spare*, fitted with the most advanced coil-handling equipment available. Thus *Bliss-engineered* improvements are helping Sandvik raise its already high standards for surface finish, flatness, straightness and accuracy of gage.

You find Bliss Rolling Mills and Accessories in leading ferrous and non-ferrous plants everywhere. They are effectively employed for breakdown, finishing and handling operations on solids, shapes, sheet, strip and foil. For details, write for your copy of our new 52-page brochure.

E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO
E. W. Bliss (England) Ltd., Derby, England
E. W. Bliss Company (Paris), St. Ouen sur Seine, France

Remember:
for Presses, ROLLING MILLS and Special Machinery...
It's Bliss!

Wagner
ELECTRIC MOTORS
...the choice of leaders in industry



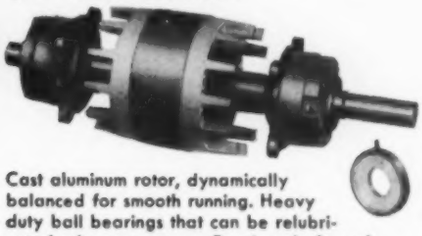
Wagner
CAST IRON FRAME MOTORS
resist corrosion...

Wagner cast iron motors are built for use in chemical plants, oil fields, refineries, steel mills—wherever protection against corrosion is a required feature. They are totally-enclosed and fan-cooled to fully protect their operation against corrosive agents, dirt and dust.

Where additional protection against explosive atmospheres is desired, an explosion-proof design (type JP) is available. Both the standard (type EP) and the explosion-proof types are built in ratings from 2 to 250 hp, with either normal or high torque characteristics. Wagner Bulletin MU-132 gives complete information on these corrosion-resistant motors. Write for your copy today.

features like these give extra protection -

Frame of rugged cast iron. Completely protected laminations. Special varnish treated windings. Cast iron gasket-sealed conduit box.



Cast aluminum rotor, dynamically balanced for smooth running. Heavy duty ball bearings that can be relubricated when necessary. Running shaft seal.

Cast iron endplates, ribbed to add extra mechanical strength.

Externally mounted blower of corrosion-resistant material—malleable iron on type EP, non-sparking bronze on type JP.

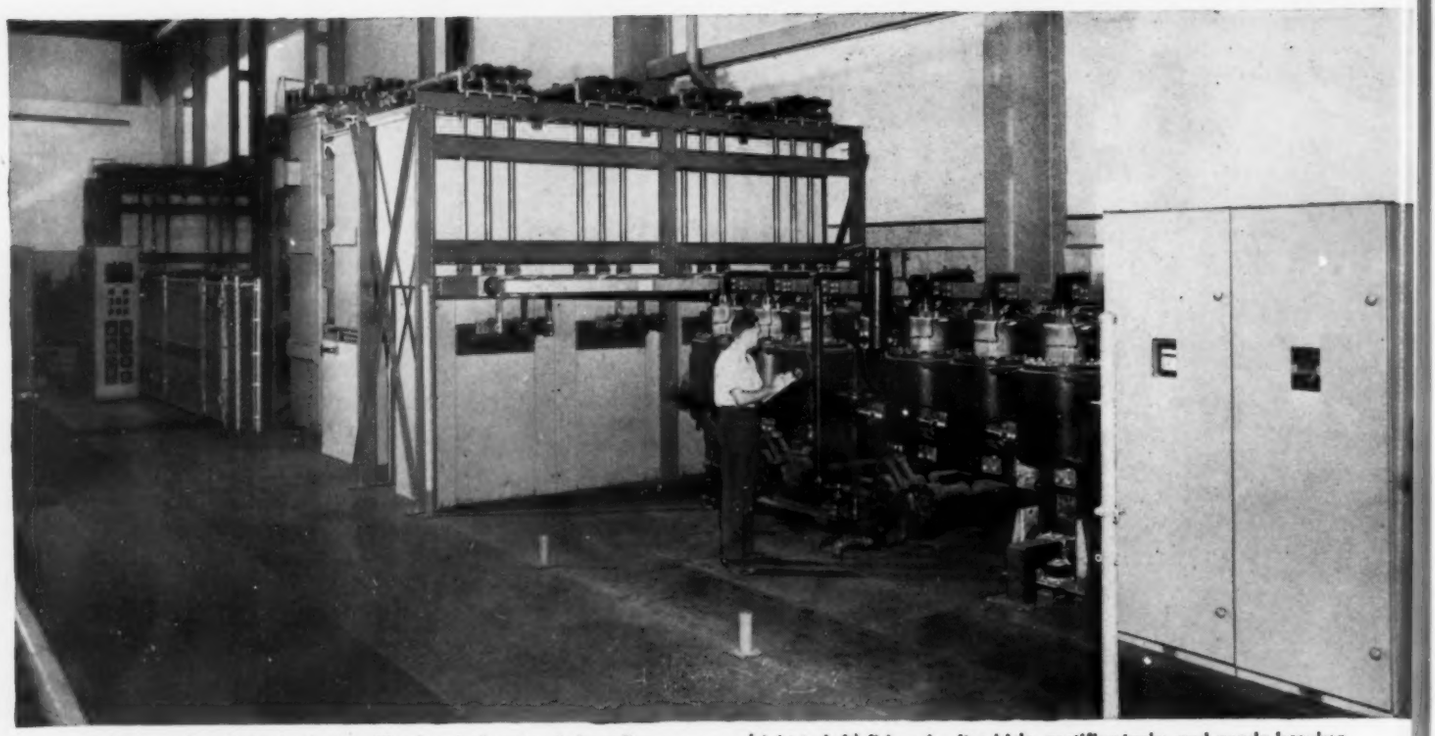
WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

®Wagner Electric Corporation EST. WE 1891

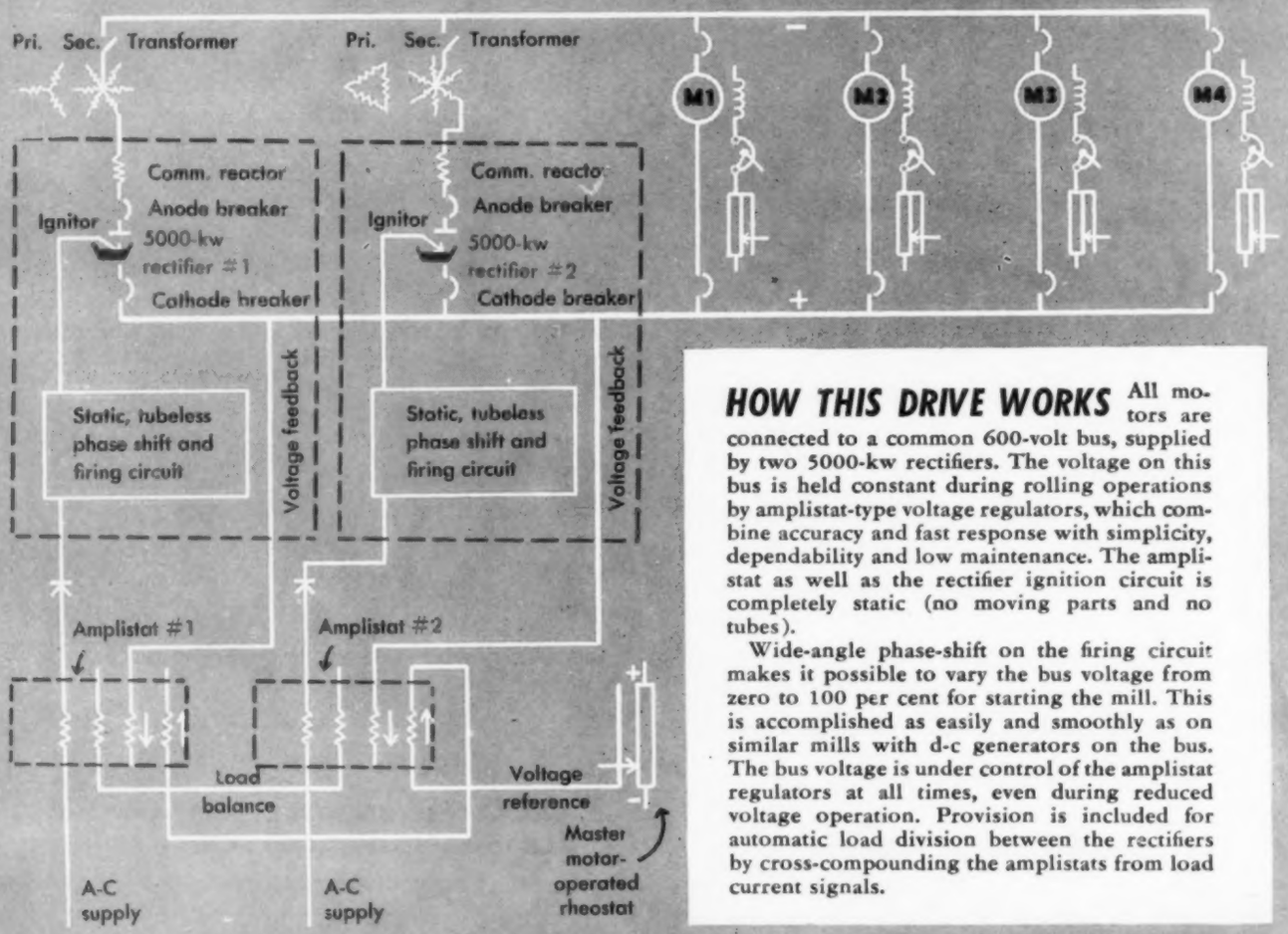
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS • AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

MU3-0



Outstanding feature of this mill's electrical system is its reliance on rectifiers alone for its main drive's d-c power supply. Photo shows (right to left) firing circuit cubicle, rectifier tanks, and anode breaker of one of the two G-E 5000-kw rectifiers.

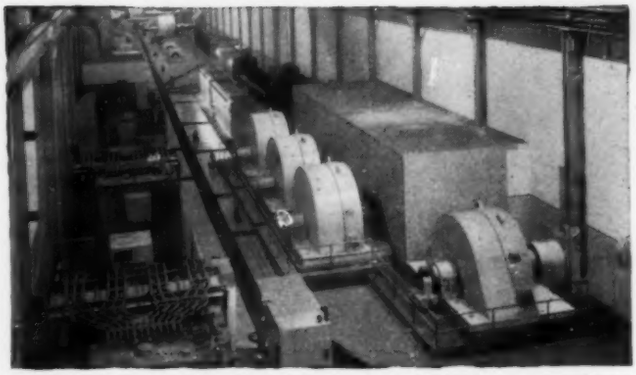


HOW THIS DRIVE WORKS

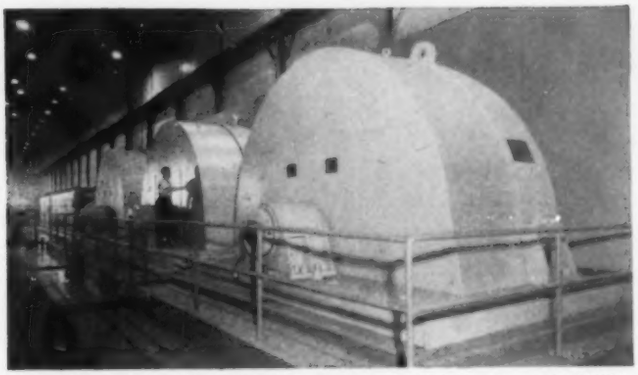
All motors are connected to a common 600-volt bus, supplied by two 5000-kw rectifiers. The voltage on this bus is held constant during rolling operations by amplistat-type voltage regulators, which combine accuracy and fast response with simplicity, dependability and low maintenance. The amplistat as well as the rectifier ignition circuit is completely static (no moving parts and no tubes).

Wide-angle phase-shift on the firing circuit makes it possible to vary the bus voltage from zero to 100 per cent for starting the mill. This is accomplished as easily and smoothly as on similar mills with d-c generators on the bus. The bus voltage is under control of the amplistat regulators at all times, even during reduced voltage operation. Provision is included for automatic load division between the rectifiers by cross-compounding the amplistats from load current signals.

Another example of G-E drive engineering at work!



Motor room, seen from overhead crane cab, shows how compactly the two G-E rectifiers (left) fit in this motor room of limited width.



Main drive motors for mill's four stands include these three G-E 5000-hp d-c motors, plus another 3500-hp direct-connected unit, not shown.

Rated at 1550 fpm, this 86-inch hot strip mill produces heavy-gage sheet steel for welded pipe and other uses. Strip passes from right to left.

Operating pulpit includes (left to right) flying shear desk, screw-down desk, and speed desk. Mill is directly opposite the operators.

G-E rectifiers power main drives on large hot strip mill

Part of co-ordinated G-E equipment, they supply d-c power to drive new 86-in. finishing mill at nearly 1500 fpm

Here's another G-E first! This new 86-inch hot strip finishing mill in a large Western steel mill—electrically equipped and engineered throughout by General Electric—depends on two 5000-kw G-E rectifiers alone to convert a-c to the d-c power required for its main drives. This unique, complete drive installation includes main and auxiliary motors, control equipment, switchgear, transformers and ventilating equipment. G-E rectifiers offer advantages like these:

Low installed cost.

Fast, economical installation. Rectifiers, being static, do not need heavy foundations.

Little floor space needed. Rectifiers can be easily located on a balcony, or split up into sections, or placed nearer the centers of d-c load to cut the length and expense of d-c feeders.

Substantial power-cost savings. Rectifier efficiency is high, especially at light loads.

Low maintenance costs—minimum of moving parts, periodic inspections reduced to minimum.

Excellent service continuity. Rectifier tanks are easily, quickly replaced when necessary.

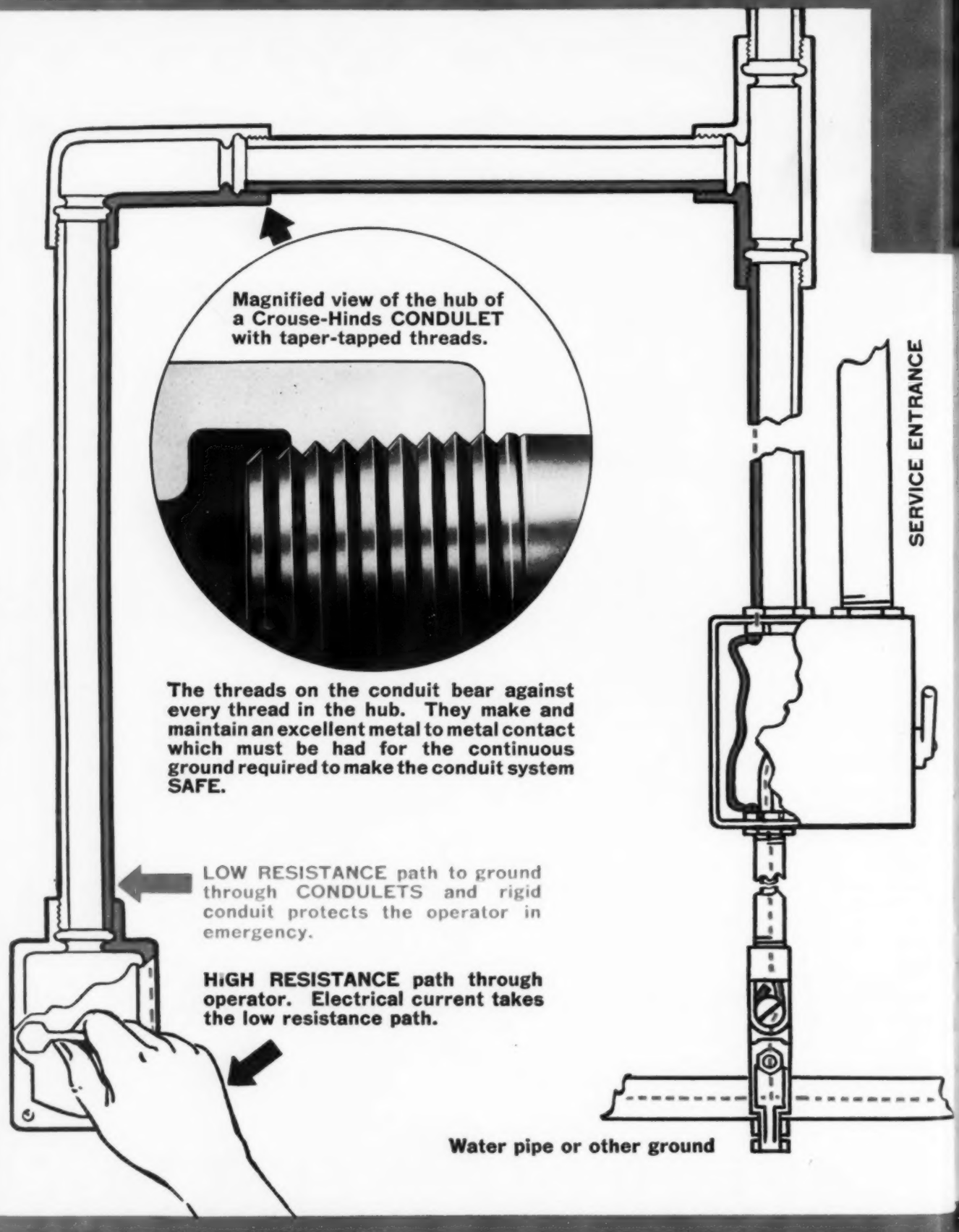
Low ventilating costs. Major losses of rectifiers are removed by water cooling.

Whatever solution is right for *your* drive engineering problem, you'll find it faster, easier, and at less cost by letting a G-E steel-mill specialist team up with your technical staff. Call him in—early in your planning. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

659-82

CONDULETS* and rigid conduit ...


Magnified view of the hub of a Crouse-Hinds CONDULET with taper-tapped threads.
The threads on the conduit bear against every thread in the hub. They make and maintain an excellent metal to metal contact which must be had for the continuous ground required to make the conduit system SAFE.
LOW RESISTANCE path to ground through CONDULETS and rigid conduit protects the operator in emergency.
HIGH RESISTANCE path through operator. Electrical current takes the low resistance path.
SERVICE ENTRANCE
Water pipe or other ground

... the wiring method that gives you maximum SAFETY for workers AND property

Typical CONDULETS

Type T Obround Condulet

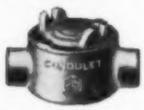
Type LR Obround Condulet

Type FS Condulet

Type WMK Enclosed Safety Switch Condulet

Type VC Vaportight Industrial Lighting Fixture

Type EVA Explosion-Proof Industrial Lighting Fixture



Type GUAC Explosion-Proof Junction Condulet

Type EPC Explosion-Proof Line Starter

Type GCH Groundulet Safety Circuit Equipment

A low resistance grounding circuit is of vital importance in any electrical system. The combination of rigid conduit and CONDULETS provides the safest installation because this combination assures the permanence of the grounding circuit. In any grounding path, every joint that isn't tight in the beginning or loosens from vibration makes a high resistance point. Such high resistance creates a hazard for workers and can cause disastrous fires.

All rigid conduit has tapered threads and all CONDULETS (made only by Crouse-Hinds) have taper threaded hubs. This combination makes a secure joint that is tight in the beginning and stays tight. These joints will not loosen from vibration and assure a reliable and permanent low resistance path to ground. This SAFETY feature provides maximum protection against personal injury and fire.

Besides safety, a CONDULET installation gives you these additional definite advantages:

- **MECHANICAL PROTECTION.** Crouse-Hinds sturdy cast Feraloy CONDULETS and rigid conduit provide the best possible protection against accidental damage to the wiring and equipment. Prevents costly shutdowns.
- **FLEXIBILITY.** To meet all the diverse requirements of modern electrical layouts, CONDULETS are made in a wide variety of shapes and sizes with varied hub arrangements, including a full line of CONDULETS with detachable hub plates.
- **ECONOMY.** The installed cost of Crouse-Hinds CONDULETS and rigid conduit compares favorably with other wiring methods. The added advantages make it the really economical method that pays dividends over the years.
- **CORROSION RESISTING.** Cast Feraloy CONDULETS give the best protection wherever moisture, dust, or corrosive atmospheres are present.
- **UNIVERSAL APPLICATION.** You can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies.
- **QUALITY.** The trademark CONDULET stands for the highest quality, reliability, and long life.
- **VARIETY.** More than 15,000 items are listed in the CONDULET Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations.

On YOUR next electrical layout, plan to get all the benefits of sturdy cast Feraloy CONDULETS and rigid conduit . . . the universal wiring method.

* *CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

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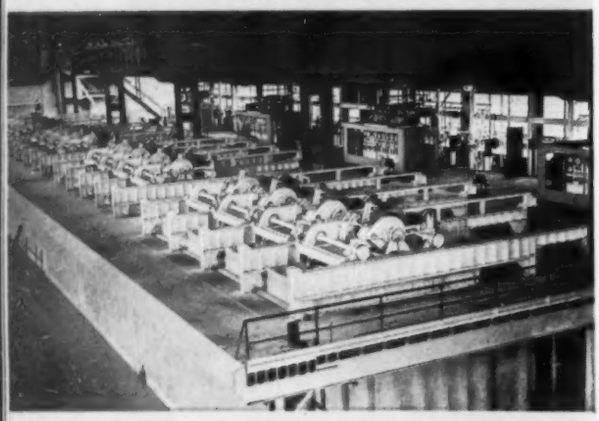
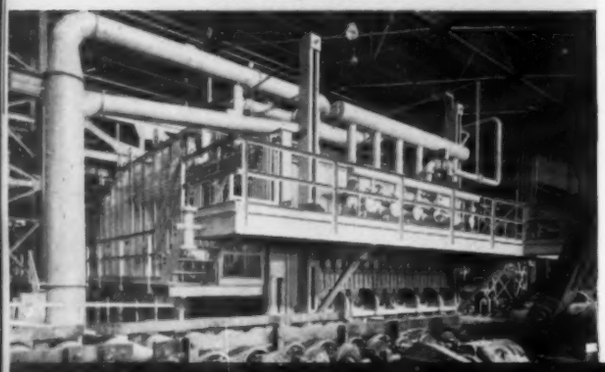
WHEN URGENT PRODUCTION SCHEDULES

One-way fired soaking pits.



Slab heating furnaces.



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'Surface' SERVES THE STEEL INDUSTRY

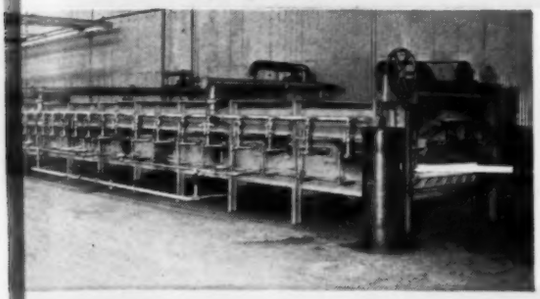
One-Way Fired Soaking Pits • Billet Reheating Furnaces • Slab Heating Furnaces • Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces • Controlled Atmosphere Annealing Covers for Wire and Rod • Controlled Atmosphere Annealing Covers for Coil and Sheets • Continuous Furnaces for Heat Treatment of Steel Plate • Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock • Continuous Type Bright Annealing and Normalizing Furnaces • Prepared Gas Atmosphere Generating Equipment • Pit Type Convection Furnaces for Rod Annealing • Stress Relief Furnaces • Wire Patenting Furnaces

DEMAND

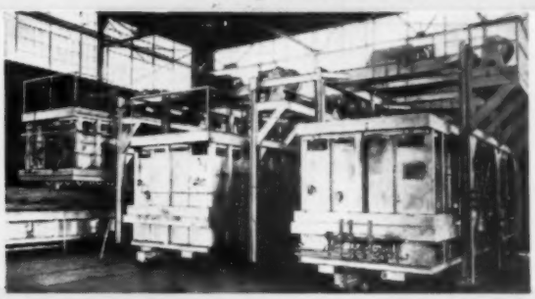
heat

FROM INGOT THROUGH FINISHED PRODUCT

Wire patenting furnaces.

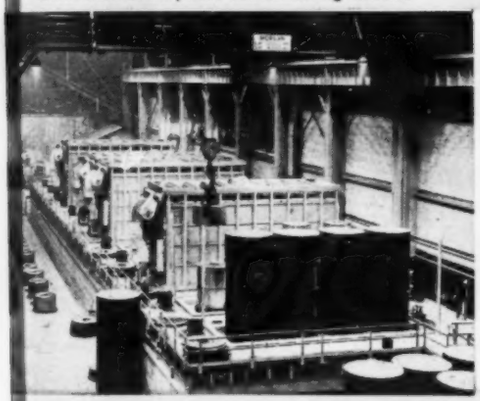


Batch type carbon correction annealing furnaces.

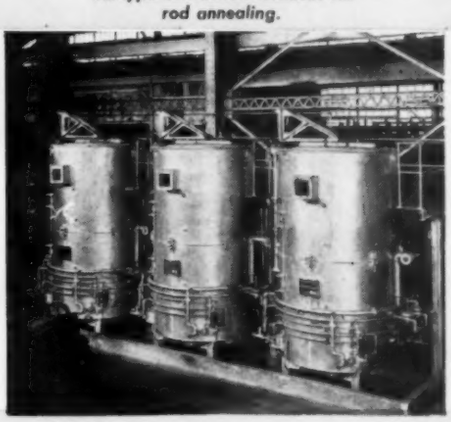


Continuous bright annealing and normalizing furnaces for tubing.

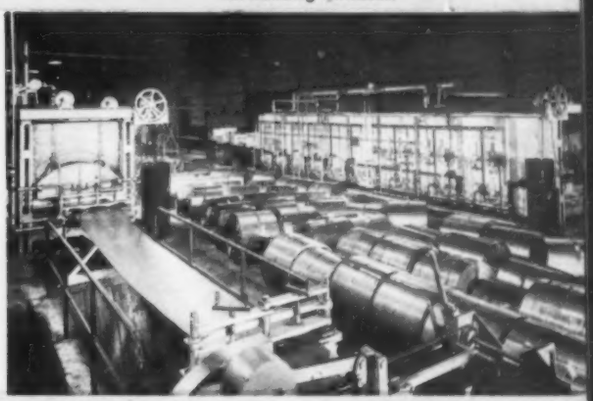
Controlled atmosphere coil annealing covers.



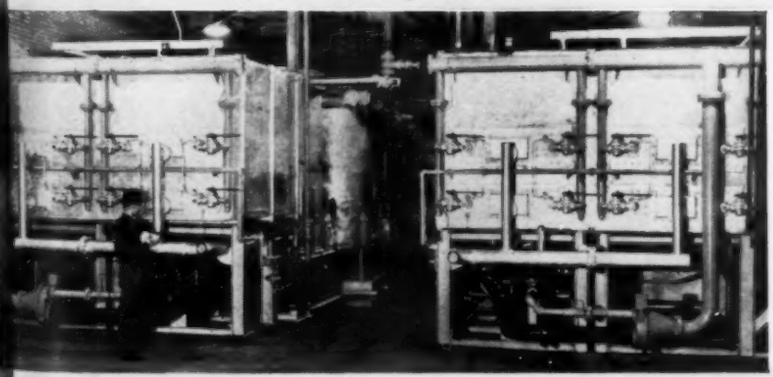
Pit type convection furnaces for rod annealing.



Continuous strip annealing and normalizing furnaces.

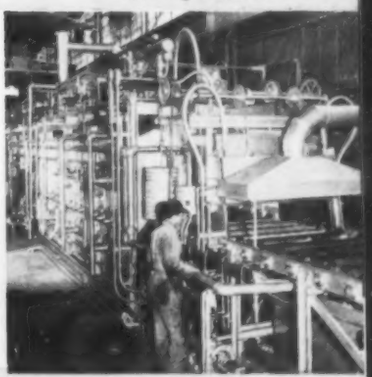


Prepared atmosphere generators.

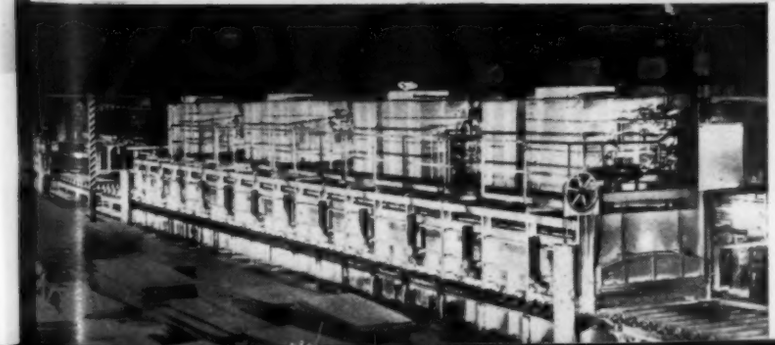


Stress relief furnaces.

Continuous controlled atmosphere annealing furnaces.



Continuous armor plate heat treating furnaces.



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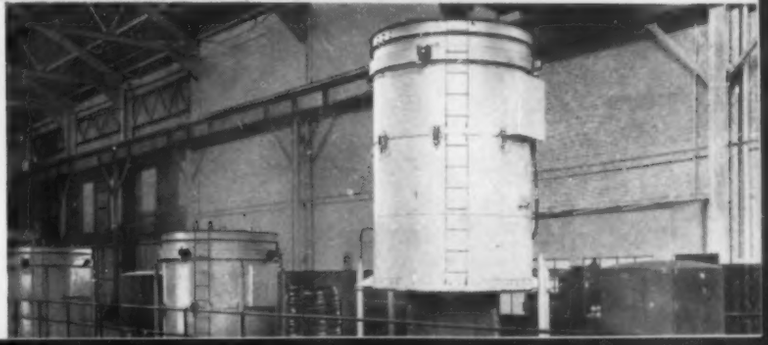
Controlled atmosphere wire and rod annealing covers.



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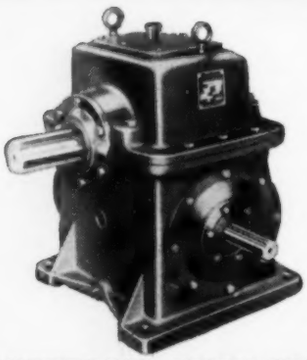

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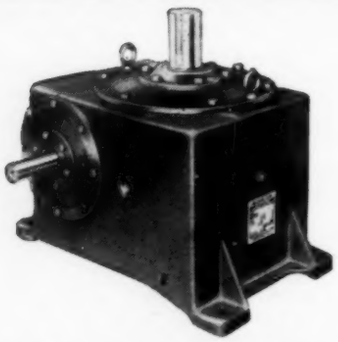

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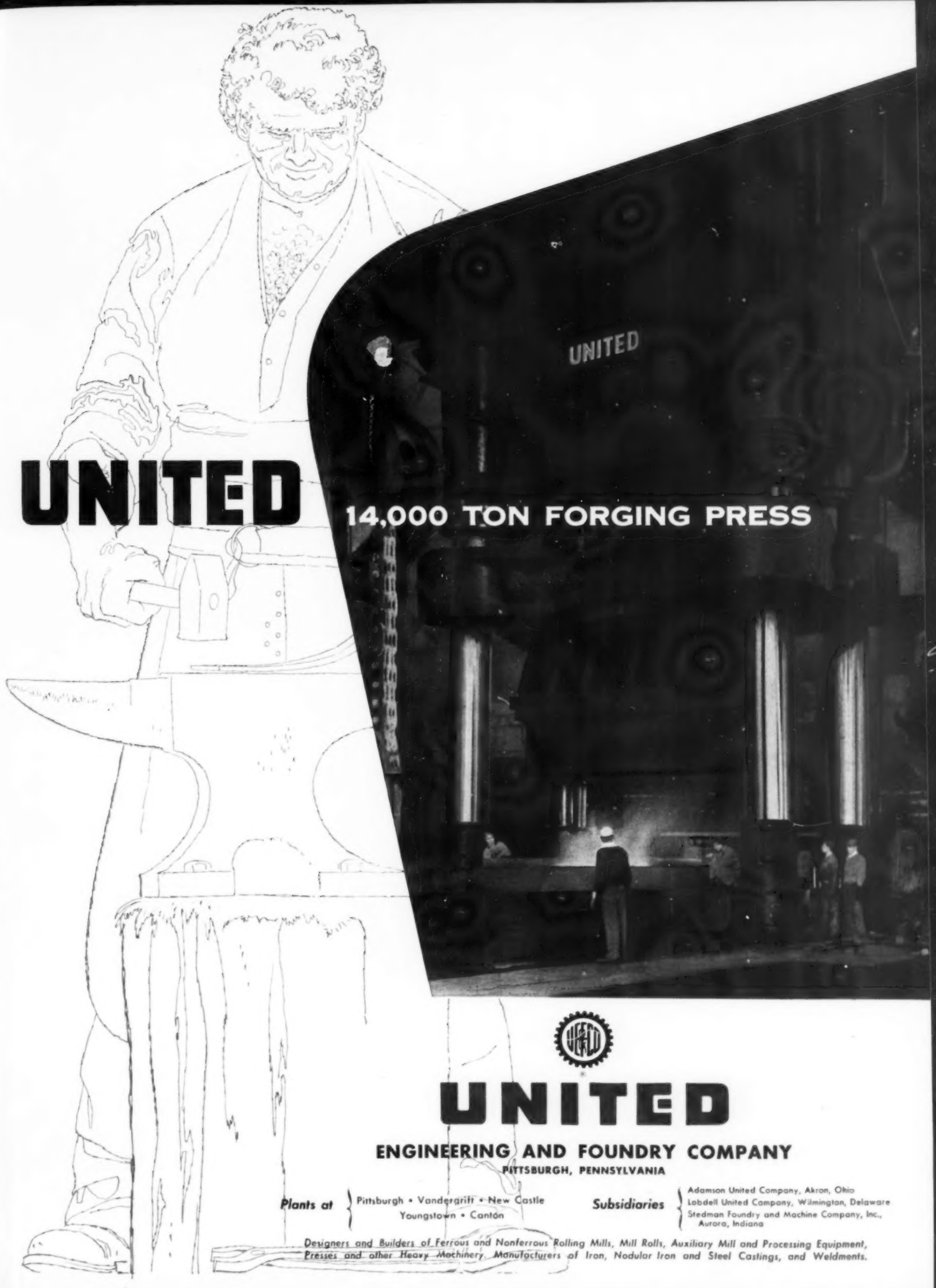

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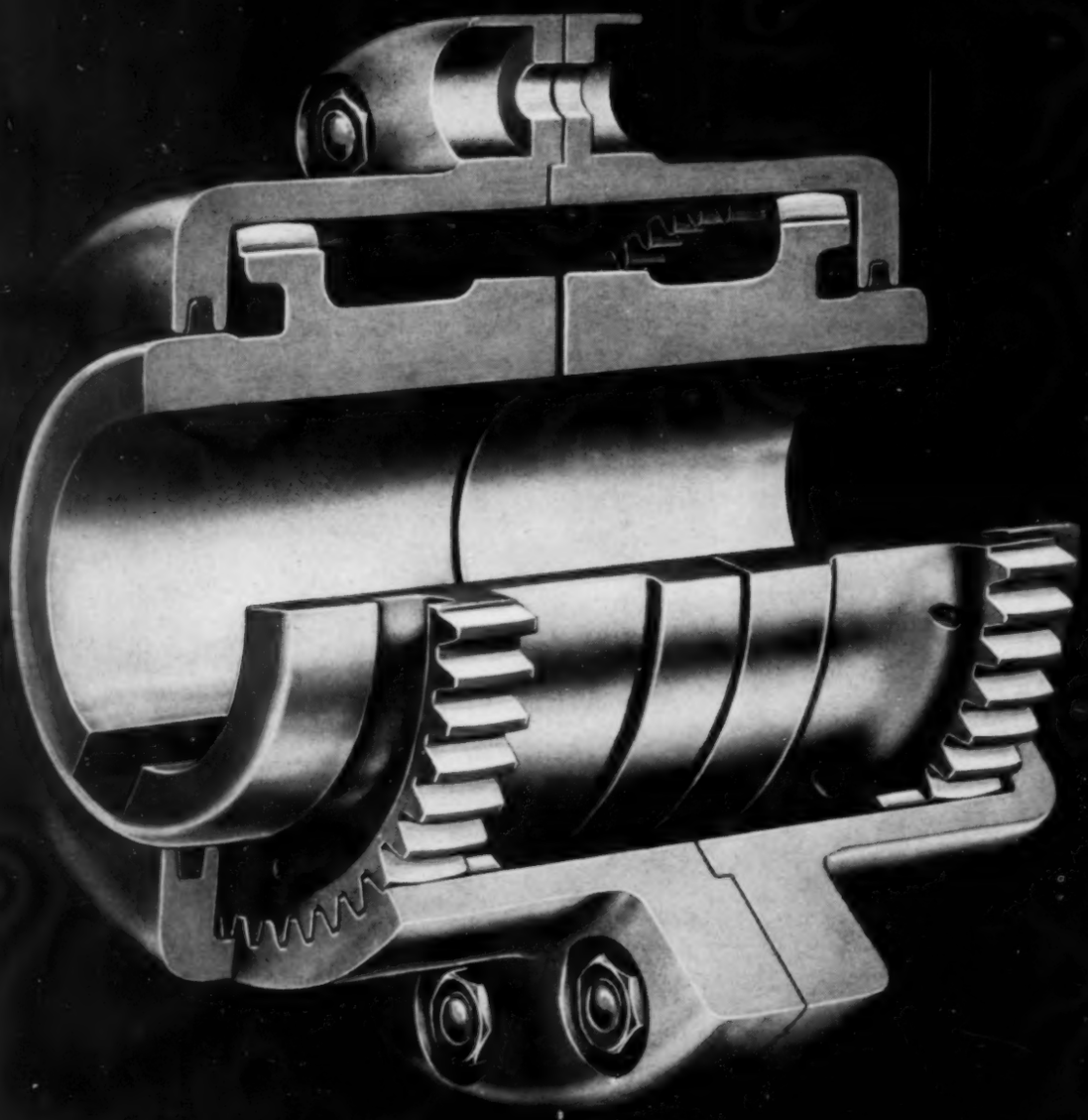

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Looking for a better rust preventive for cold rolled products?

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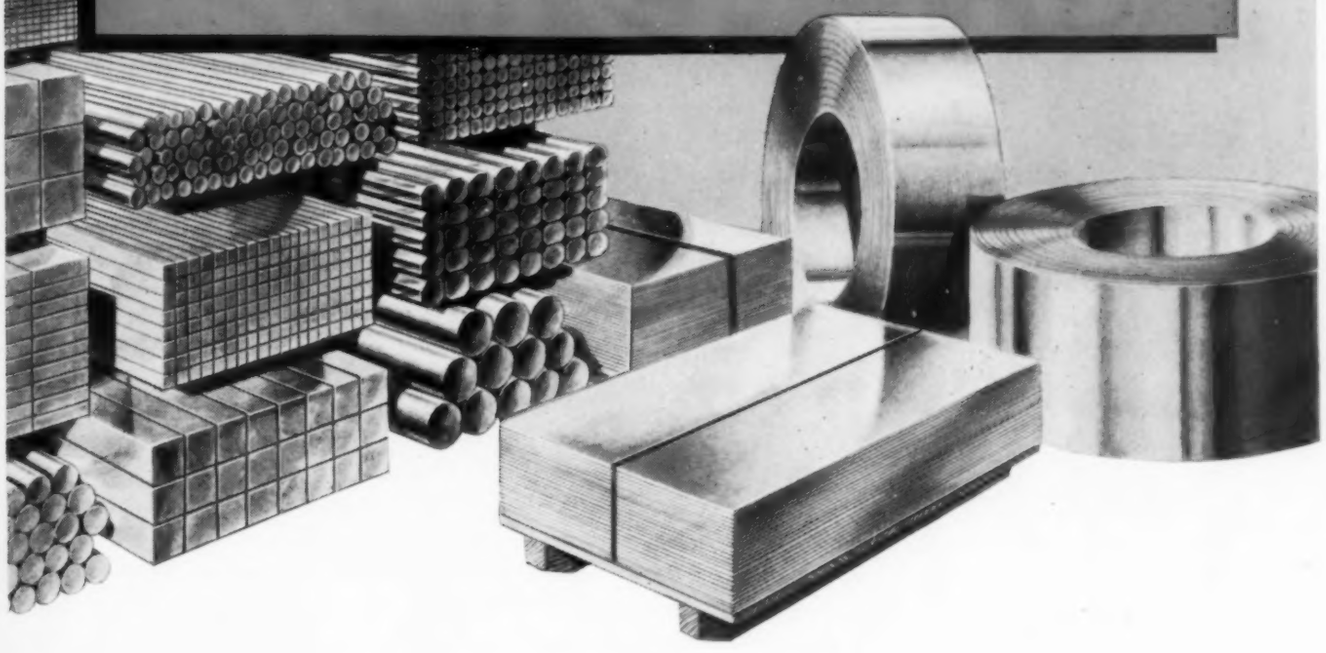

Gulf No-Rust provides positive protection against corrosion for cold rolled steel products under severe conditions of storage and shipment. It is ideal for products exposed to widely fluctuating ambient temperatures and humidities, highly corrosive atmospheres, and outdoor weathering.

Gulf No-Rust is available in several grades; one, an oil-film type that has strong polar characteristics; and several petrolatum-type materials which provide films of varying degrees of toughness. All are easily applied, provide good coverage per unit of volume, and are easily removed by vapor degreasing or by washing with Gulf Stoddard Solvent.

If your customers report cases of surface spoilage due to corrosion, it will pay you to investigate the advantages of Gulf No-Rust. Ask a Gulf Lubrication Engineer for further details. He will fully inform you on the suitability of Gulf No-Rust for various methods of application, types of metal surface, size of product, length of time for which protection is required, conditions of storage or shipment and ease of removal. Write, wire, or phone your nearest Gulf office today.

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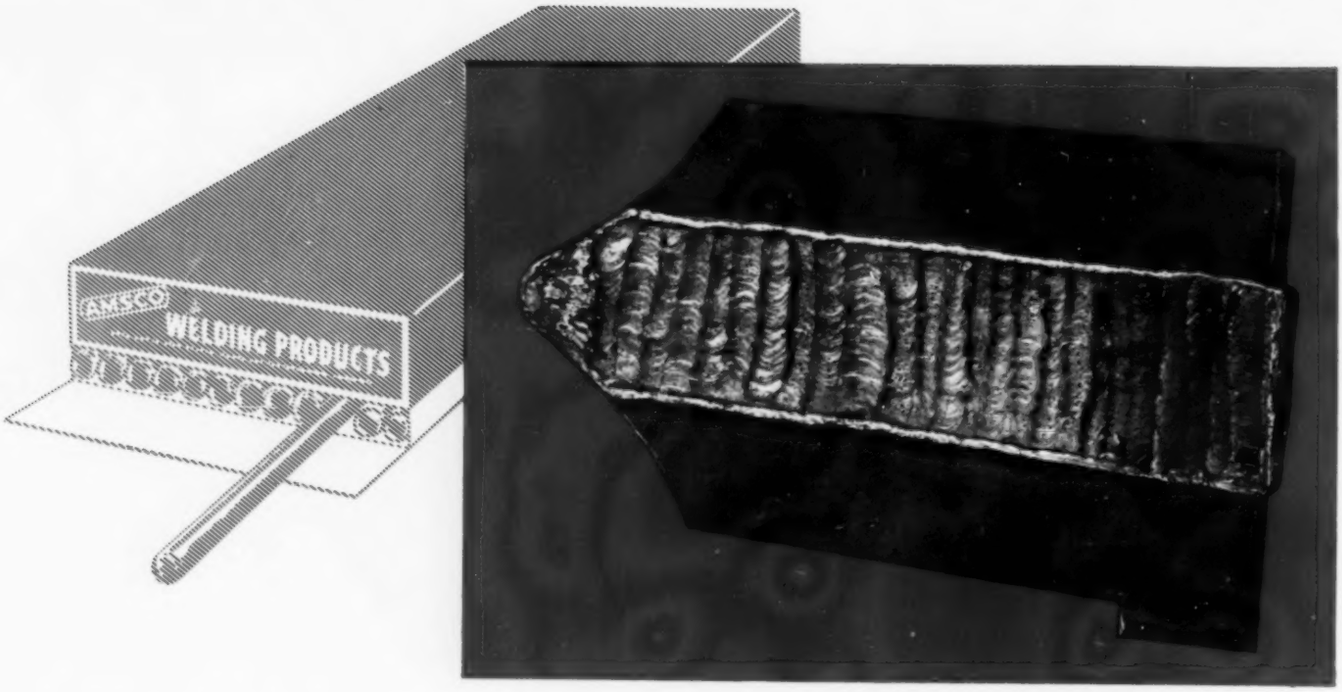

How to run more tonnage — with fewer shutdowns

How to Amscoat Mill Guides . . .

This procedure sheet gives complete details . . . the AMSCO electrode to use and method of application. Also lists electrode recommendations for other iron and steel applications. Free copy on request.

An example of how AMSCOATING with Amsco Hardfacing Electrodes can save materials, manpower and money.

A large Eastern seamless steel pipe manufacturer can quote—from the record—on the big savings possible through Amscoating!

Before Amscoating, Mill Guides had to be removed and reground after running an average of 1200 tons. After Amscoating with an Amsco electrode specially developed to stand up under heat and abrasion, the same guides ran 37,117 tons without grinding—*over 30 times longer*—and were still in good condition for further service!

Amscoating can reduce shutdowns, repairs and replacements, as demonstrated by this actual case history. The inevitable result is that production goes *up* . . . and maintenance costs *down.* Write today for catalog on dollar-saving Amsco Electrodes and name of your nearest Amsco Distributor.

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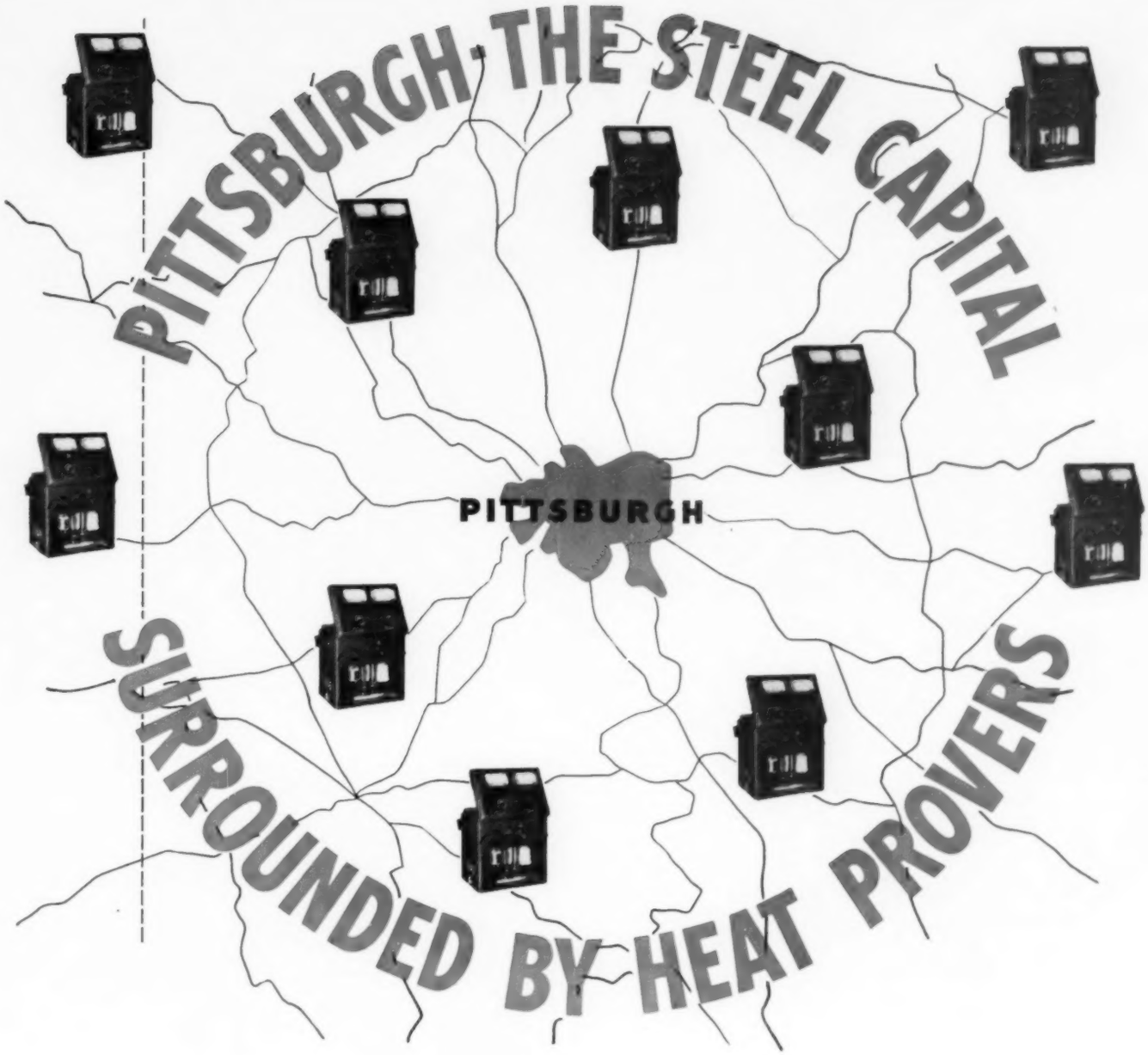

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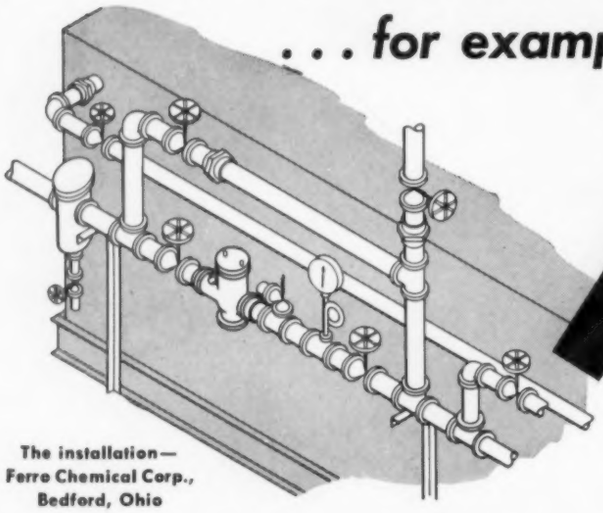

The installation—
Ferro Chemical Corp.,
Bedford, Ohio

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WORKING CONDITIONS: Initial steam pressure of 70 psi to be reduced to 13 psi, and maintained without significant fluctuation whether one, both, or neither of the ovens is being operated.

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RESULT: For more than 5 years, without interruption and with no more than routine maintenance, the Crane No. 960 Regulator has given complete satisfaction. Operating like new, and since all wearing parts are renewable, it will virtually never wear out. User remarks on unusual simplicity of adjustment.

Another typical case history, demonstrating the bigger value and lower ultimate cost of Crane Quality Valves. And why . . . More CRANE VALVES are used than any other make!

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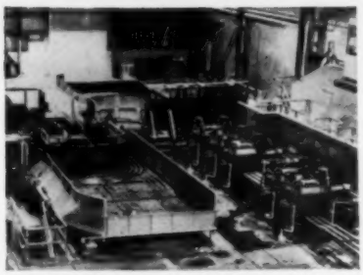

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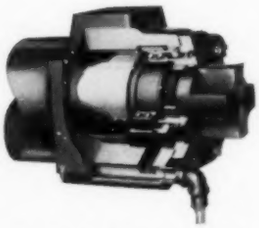
. . . built by specialists with over 60 years of pioneering in the field.



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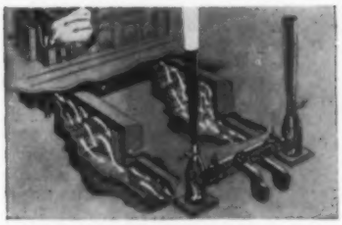
. . . Morgan-Connors give high production, with low die cost, low power cost, low space requirement.



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RM-42

BEST WAY TO STRIP BIG INGOTS AT LESS COST

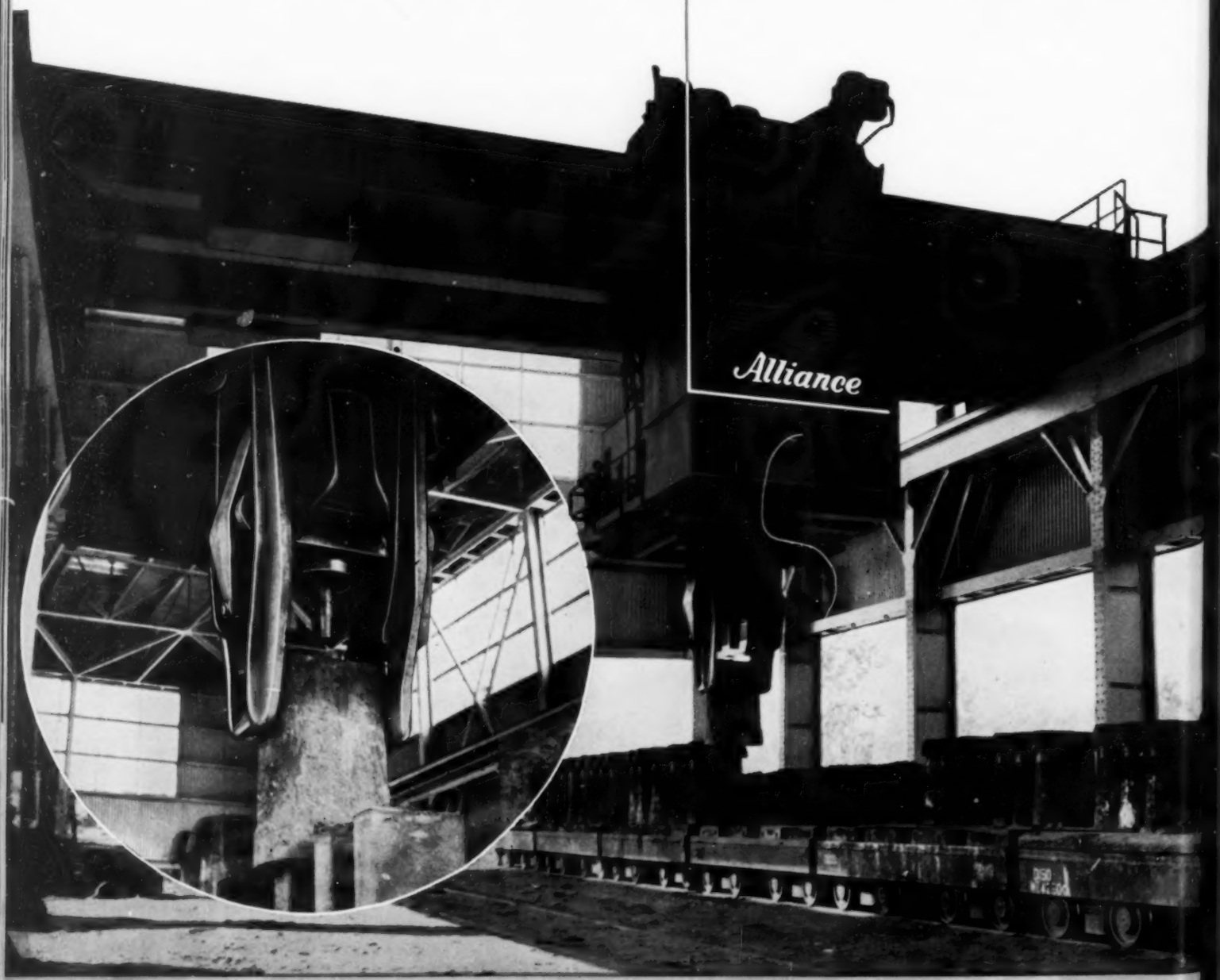
● The 200-ton push-pull, screw-type Alliance Stripper Crane, pictured below, is helping the Fontana Works of Kaiser Steel Corporation produce better ingots at less cost.

The stripper is equipped both with a retractable bullnose and gripping tongs so that the operator, unassisted, can make all necessary adjustments to strip either large end-up or small end-up ingots. The compact cab provides the operator with maximum visibility and safety, while the smooth-working mechanisms respond instantly to the slightest direction of simplified finger-tip controls.

Alliance . . . world's largest builder of the world's largest cranes . . . builds strippers having a name-plate rating of 400 tons and an overload rating of 1200 tons. This combination results in fewer stickers and consequent saving in costly alloy ingots as well as moulds. These strippers are equipped with the electric counterweight developed by The Alliance Machine Company which prevents the ingots from falling when stripped, thereby preventing damage to the ingot stools, axles, anti-friction bearings of the ingot buggies . . . reducing maintenance to a minimum.

Alliance Cranes like this can provide you with more than enough strength and versatility to meet steadily increasing production demands.

Let us help you plan for more economical lifting power in your plant with these big, dependable cranes. Write today for an analysis of your particular requirements.



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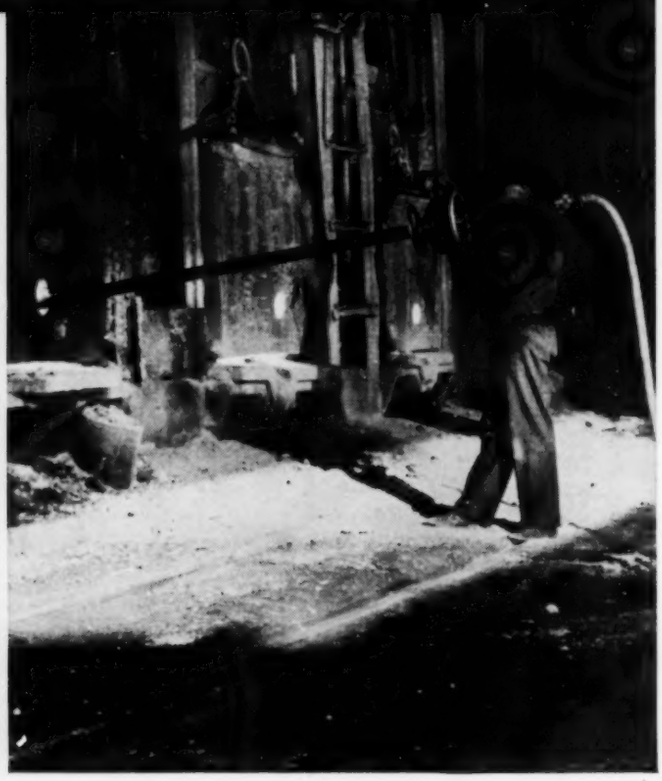
FOR MORE INGOT TONNAGE PER HEAT

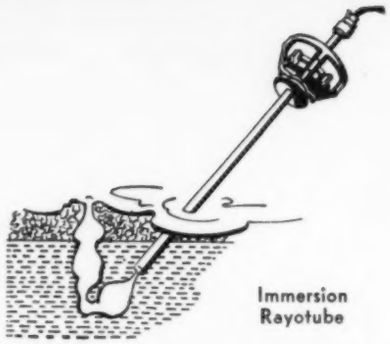
Measure Temperatures By Immersion Thermocouple or Immersion Rayotube



OPEN HEARTH and electric furnace shops can now choose between two tested L&N methods for measuring steel temperatures during the melt. Either an Immersion Rayotube or an Immersion Thermocouple is plunged momentarily beneath the surface to measure the temperature of the bath, while a dependable Speedomax Recorder displays the information where all concerned can use it.

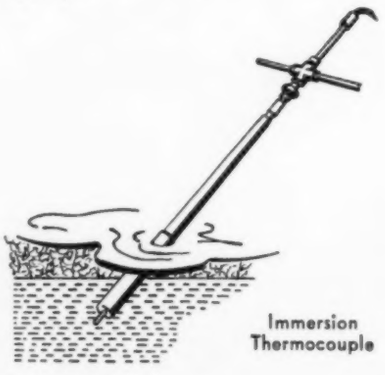
Either method helps improve ingot production by warning if the steel is too hot or too cold for tapping. Recently published talks before national steel associations indicate that production losses have been sharply cut in plants where temperature is properly measured while the melt is finished off for tapping.

It pays to select your immersion-measuring equipment from a source which makes both radiation and thermocouple types. The two equipments cost about the same initially; among the factors which should be weighed without prejudice are: size and type of furnace, type and quality of steel, experience of helpers in using instruments, supervisory set-up and the differences in maintenance supplies and labor. If you'll contact our nearest office, or 4942 Stenton Ave., Philadelphia 44, Pa., we'll be glad to supply such other information as you desire.



Immersion Rayotube

Rayotube gets its reading inside a bubble blown by compressed air or other gas, while Thermocouple contacts the metal directly. Both methods give the "heart" temperature of the molten steel, and give it in time for any changes necessary before tapping.



Immersion Thermocouple

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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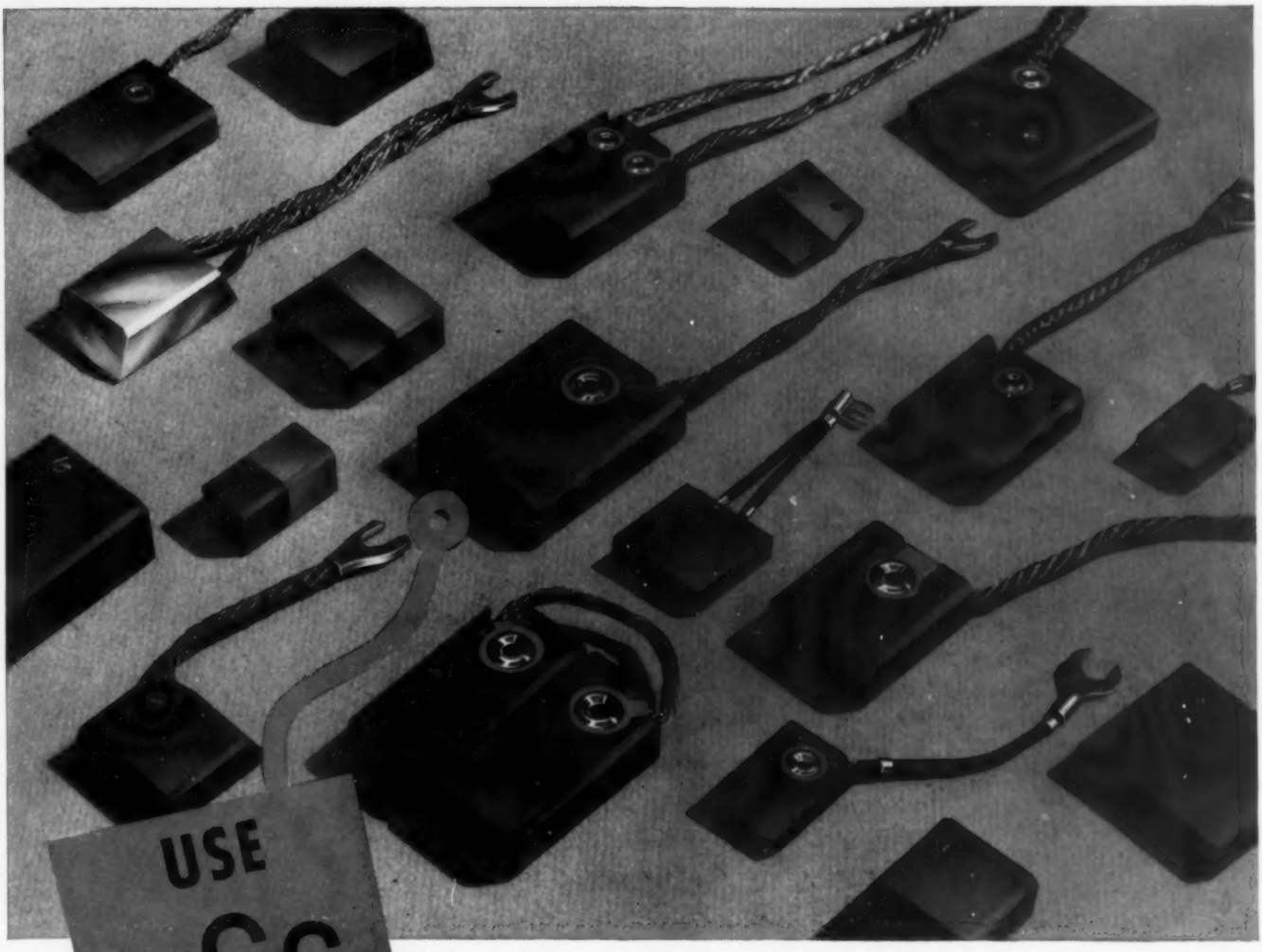

A Complete Line of Motor and Generator Brushes and Contacts For Every Steel Mill Application

USG Industrial Brushes and Contacts are made in carbon, carbon-graphite, electro-graphitic, pure graphite and metal-graphite grades for alternating and direct current equipment of all kinds. They are made in production and replacement lots for either standard or special applications; many variations of the standard grades are also available in split type and solid form for the special applications.

Complete manufacturing facilities plus modern laboratory techniques help make USG Industrial Brushes and Contacts the best you can use in all types of rotating electrical equipment.

Write today for 40-page catalog giving complete information on standard USG grades.

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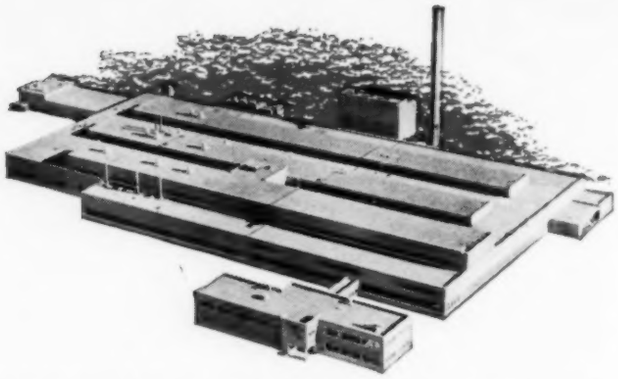

N-B-M Meadville . . . where the welcome mat is out. We're proud of this plant—its equipment and the skilled people who work in it. Proud enough, in fact, to offer a standing invitation to Blast Furnace Superintendents or other steel mill officials to visit us. When can *you* make an inspection trip?

These Bosh Plates take it standing up

Here's where you'll find *vertical* molding of copper castings . . . resulting in cleaner metal throughout.

Another reason why N-B-M Meadville is a name to remember when you specify copper castings. During 75 years of foundry experience, you learn many answers to better methods of production . . . methods that *improve casting quality and soundness.*

At N-B-M Meadville, one of these quality-improving production methods is *vertical molding*—eliminating chaplets. We've found—both by test and on-the-job experience—that vertical molding means uniformly higher quality. Any N-B-M Representative will welcome the chance to describe this unique method to you.

From the molding floor to the shipping room, N-B-M Meadville accomplishes what should be, and is, the main objective of this modern, well-manned plant . . . ***what you specify . . . we ship.***

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

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PLANTS IN: ST LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

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YORK Engineering & Construction Company

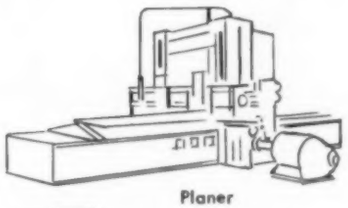
is Expanding

with purchase of the Gillespie Manufacturing Company,

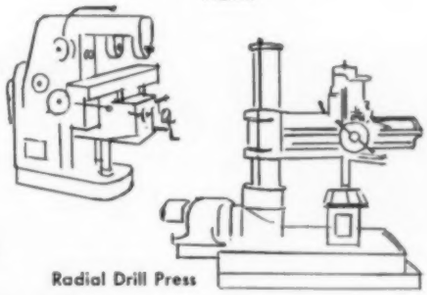
forming an affiliate:

YORK·GILLESPIE MANUFACTURING COMPANY

York's purchase of the Gillespie plant combines York's engineering and construction know-how with broad machine shop facilities capable of producing fine *custom-built* machinery and auxiliary equipment for steel mills and other industrial plants.

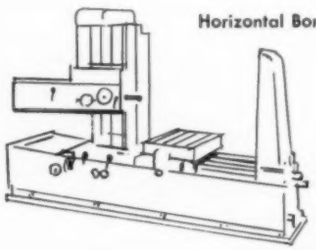


Planer

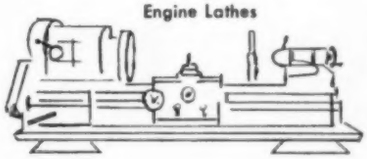


Milling Machine

Radial Drill Press



Horizontal Boring Mill



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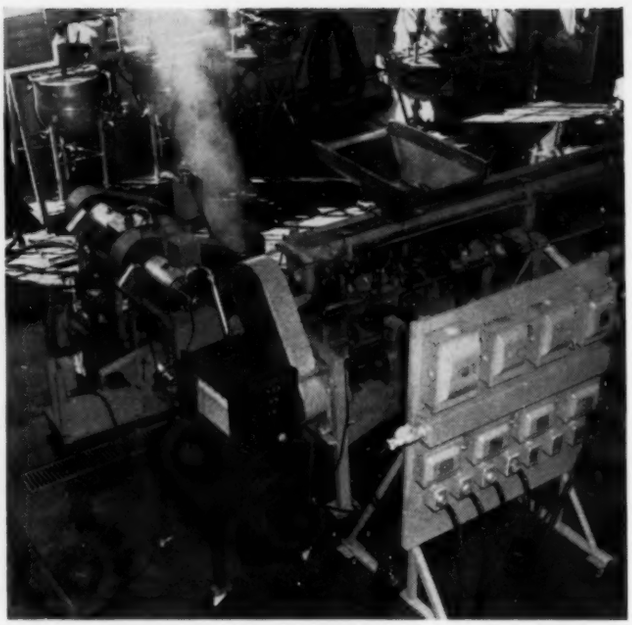
EFFECTIVE INSULATION—*Used in both research and quality control, these instruments automatically record temperatures at many points in a "test wall" of paper insulating material.*

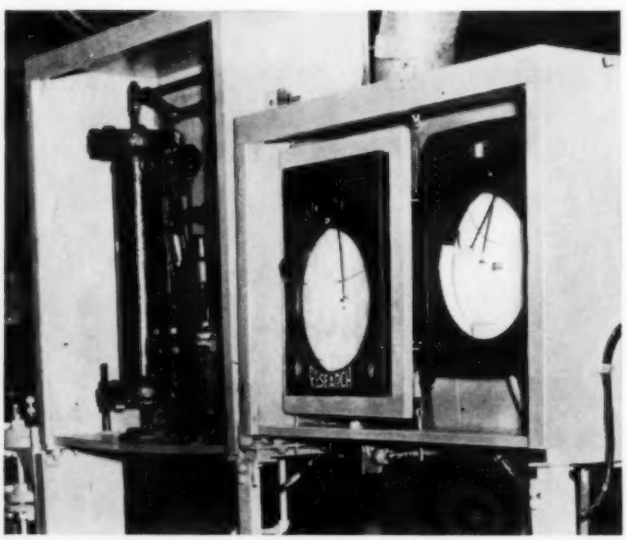


BETTER FOODS MEAN HEALTHIER BABIES—*Pilot plant at Baby Foods Division of Gerber Food Products makes use of* **ElectroniK** *recorder to check all-important processing temperatures during test runs.*

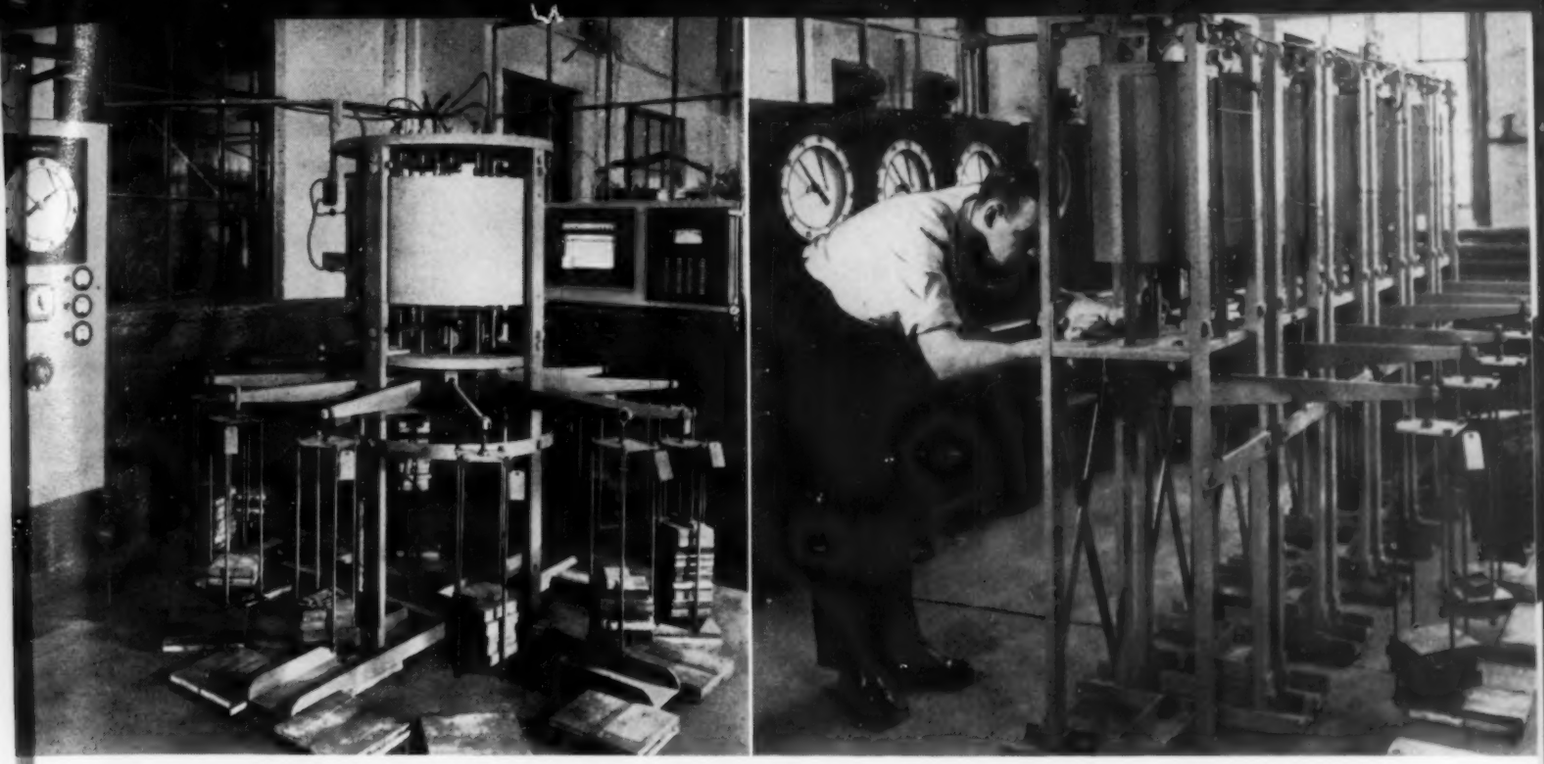
For all of industry... *especially*

Instruments

TORQUE MAGNETOMETER *used by researchers at United States Steel Corporation tells whether a steel sheet can be "drawn" into a deep cap for a ketchup bottle. Shape of curve drawn by recorder pen tells the magnetic, hence the shaping, story.*



FILAMENTS FOR FABRICS — *These instruments, in one of America's foremost rayon plants, are contributing to the stability of pilot plant processing in the development of finer filaments for tomorrow's fabrics.*



APPRAISING THE ALLOYS. *These two installations at the Watervliet Laboratories of Allegheny Ludlum Steel Corporation indicate the type of equipment and* **ElectroniK** *instruments used for "creep" and "time-to-rupture" tests on special alloys.*

for the metals industries

accelerate research

THE GREAT and growing laboratories of the metals industries evidence the prominent part played by research programs from which stem a never-ending stream of better products. And notable among the more important tools of the technician are the modern instruments and controls which accelerate research . . . help complete projects in days instead of months.

Yes, today's researchers get things done in a hurry. Thinner yet better quality tin coat, stainless clad carbon steel sheets, metals with such special qualities as resistance to rust and the ability to be deep drawn and an affinity for a firm bond with porcelain enamels . . . are but a few indications of how instruments and controls are helping speed new ideas from the drafting boards to practical realities in a minimum of time.

Brown instruments and controls, of course, have been playing a vital role in such research for many years . . . and, just as in production operations, will continue to keep pace with the increased demands of new techniques.

Our local representative will welcome the opportunity to discuss your instrumentation requirements . . . for research or full-scale production. Call him in today, he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Penna.

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BROWN INSTRUMENTS
First in Controls

● *Important Reference Data*

Write for 84-page bulletin "Instruments Accelerate Research" . . . and Data Sheets on instrumentation for a variety of specific applications.

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with the ALL-METAL Foxboro d/p Cell!

. . . gives fastest response, longest sustained accuracy, for liquid, steam, gas or air flow

Simpler in design, simpler and much less expensive to install, far easier to maintain . . . the all metal Foxboro mercury-less d/p *Cell* offers greater speed of response, permitting closer flow *control*, than has ever been possible before. Its negligible displacement and corrosion-proof construction of Type 316 Stainless Steel eliminate usual maintenance problems, even in service on highly corrosive or viscous fluids previously considered unmeasurable.

The Foxboro d/p Cell measures differential pressure by the force-balance principle and transmits pneumatically to indicating, recording, or controlling receivers. Small, compact, weighs as little as 19 lb. Ranges: from 25" to 800" H_2O. Working pressure ratings up to 4000 psi. Steel or stainless steel construction.

Thousands of d/p Cells now in use throughout industry, with many repeat orders now on our books, indicate the wide acceptance and successful performance of this revolutionary development. Write for detailed Bulletin 420. **The Foxboro Company, 581 Neponset Avenue, Foxboro, Massachusetts, U. S. A.**

- No seal pots
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RECORDING · CONTROLLING · INDICATING
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FACTORIES IN THE UNITED STATES CANADA, AND ENGLAND

Open letter to the Association of Iron and Steel Engineers!

Gentlemen:

Please accept our appreciation and our support of your recently published *Carbon Brush Standards*. After years of study and promotion of brush standardization, we are gratified that the AISE has established a line of dimensionally interchangeable, mill motor brushes. They make available to every steel mill in the country certain operating economies which to us appear both clear and substantial.

Anticipating wide-spread acceptance of your standards, we are hastening to advise mill operators that a complete line of "NATIONAL" mill motor brushes has been built to conform to AISE standard specifications in every particular—designed for optimum performance on AISE-specified motors at minimum cost. The grades employed are performance-proved by years of successful application. Shunt connections are of a vibration-resistant, tamped type.

We are now prepared to ship many of these "NATIONAL" mill motor brushes from stock. The *five* most universally used types are available as "NATIONAL" STANDARDIZED brushes —at the same low, flat price for 100 or 100,000.

Herewith is a list of "NATIONAL" brushes made to the new AISE standards. It is hoped that its use by the steel industry will further your excellent work.

Congratulations!

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation

AISE standard numbers for "National" standardized mill motor brushes

NC NUMBER	AISE STANDARD NUMBER
20-4800	STD NO. 21
20-5600	STD NO. 25
24-4800	STD NO. 29
24-5600	STD NO. 30
24-6400	STD NO. 32

Write for a complete list of "National" mill motor brushes built to AISE standards

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
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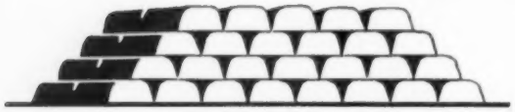


MORE THAN

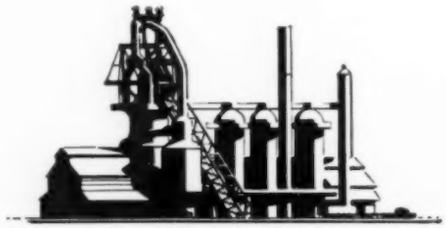
A TON AND A QUARTER

OF PIG IRON

EVERY MINUTE

TWENTY-FOUR HOURS

A DAY



FROM ONE

McKEE-BUILT

BLAST FURNACE

THAT'S an average of 1807 tons a day and it adds up to a new world's record of **56,010 tons in one month** . . . more than any one blast furnace ever produced in a single month in the history of the industry.

It takes four essentials to make a pig-iron production record—good top management, which provides superior operators, good raw materials and a McKee-built blast furnace.

Eleven of the twelve modern records established since 1931 have been made by McKee-designed blast furnaces. This quality of engineering, which consistently builds record-breakers, is one of the reasons good top management has been calling on McKee for blast-furnace and steel plant design and construction for almost half a century.

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE IRON AND STEEL AND PETROLEUM REFINING INDUSTRIES

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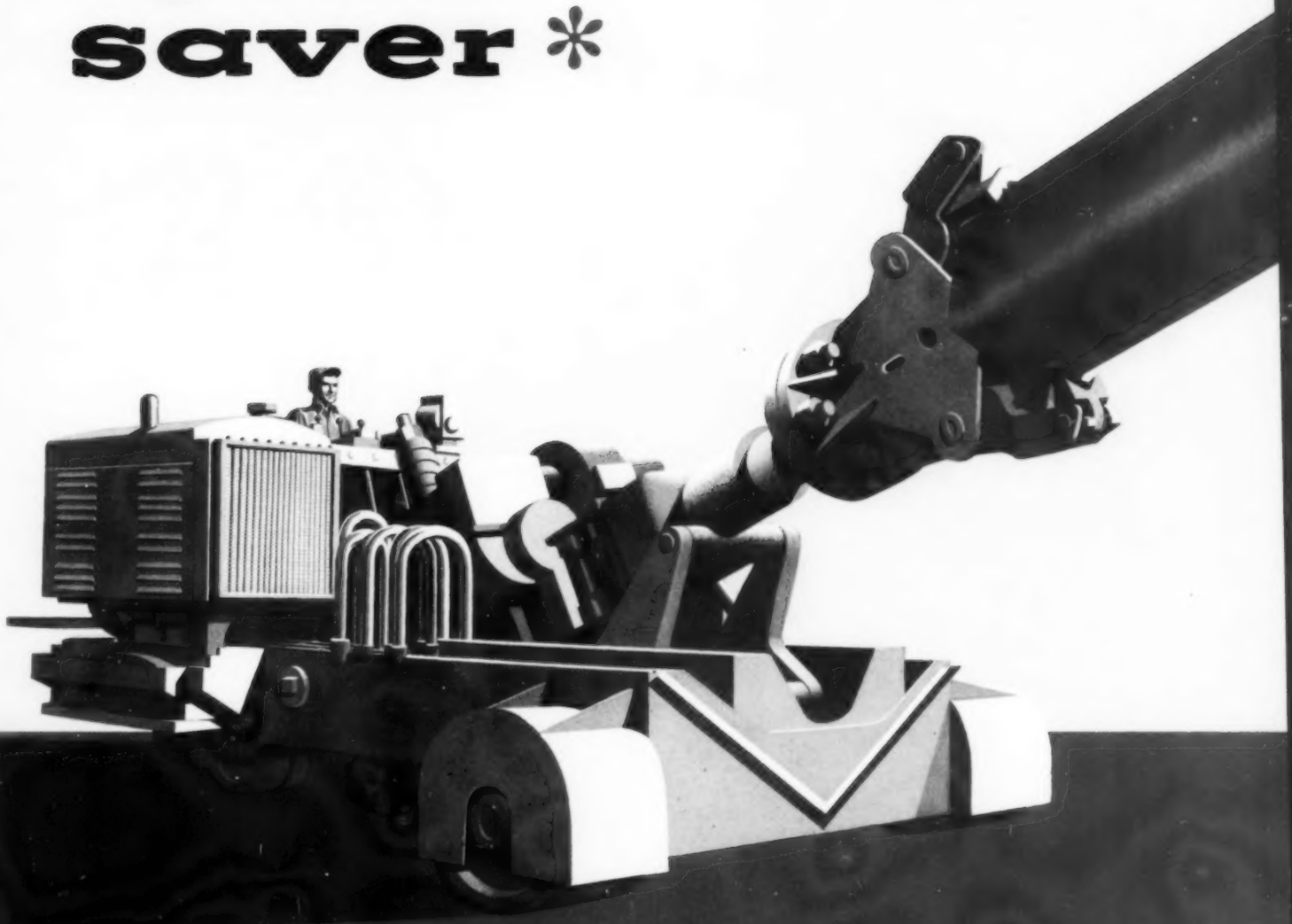
District Engineering Offices: Union, New Jersey and Tulsa, Oklahoma.

space-saver *



*Here is a prime example of Salem-Brosius' broad service to the metalworking industry in the field of equipment manufacture and industrial furnace design. It's the exclusive Auto-Floor Forging Manipulator manufactured by the Brosius Division. One of its most valuable assets is its inherent capacity for saving space on a busy forging floor. No matter where hammers, presses or heating furnaces may be placed, this remarkably mobile machine can reach them with independent agility without freezing floor space with tracks or the overhead with craneways. It has even been found that new facilities can be added without additional building construction. If you have a problem which involves the use of heating furnaces, blast furnace equipment, or charging and manipulating machines—simply call on highly diversified Salem-Brosius today.

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BROSIUS DIVISION, PITTSBURGH 15, PA.

SALEM ENGINEERING DIVISION, SALEM, OHIO

BUILT OF *Steel* AND *Mica*

NOTHING TO BREAK...

- Steel Construction
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- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
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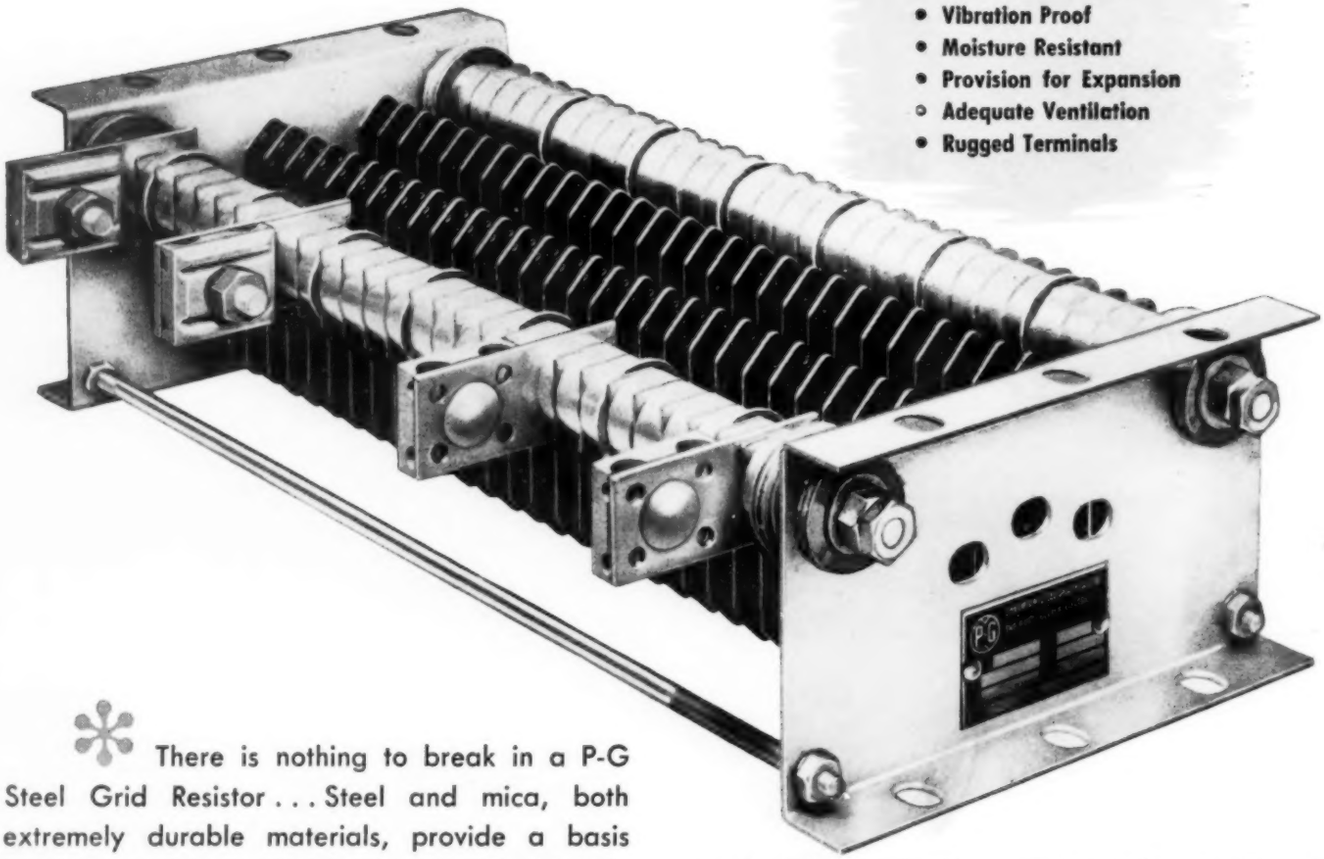


There is nothing to break in a P-G Steel Grid Resistor . . . Steel and mica, both extremely durable materials, provide a basis for the utmost in mechanical strength. Neither do vibration, nor moisture laden or corrosive atmospheres have material effect on P-G Resistors . . . This, together with provision for expansion as well as efficiency in dissipating heat produced in operation, enables P-G Non-Breakable Resistors to give long and trouble-free service . . . The next time that troublesome application is at hand, specify P-G and solve your maintenance problem.

Write for Bulletin No. 500

P-G

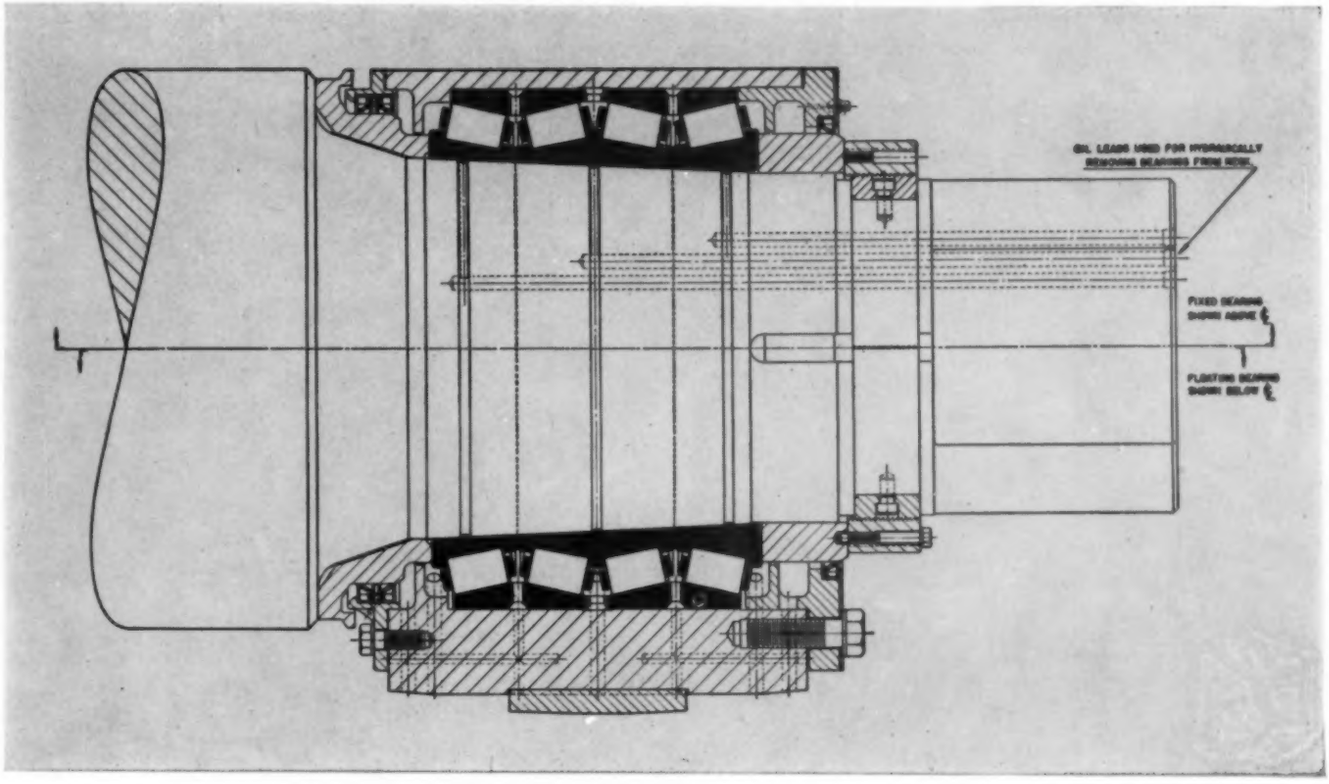
The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

NEW TIMKEN® 4-ROW BEARING FOR ROLL NECKS HAS TAPERED BORE!



Combines interference fit with easy removal!

THE Timken Company pioneers again in roll neck bearing design. This time by offering for high-speed mills a 4-row tapered roller bearing that combines maximum bearing capacity and interference fit with easy removal! The new Timken® bearing has a tapered bore—long used in 2-row bearings, but now developed and introduced in 4-row bearings for the first time.

It's the greatest development in roll neck bearings since the Timken Company pioneered the first balanced proportion bearing in 1941.

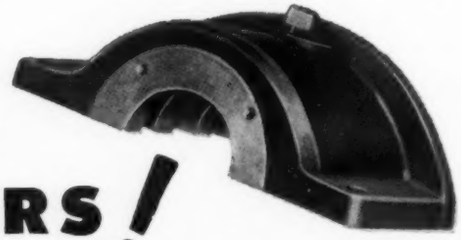
Like other Timken roll neck bearings this new tapered bore bearing permits maximum roll neck size and greater mill rigidity, eliminates need for special thrust bearings, makes possible higher rolling mill speeds, permits stopping and starting of mills without loss of steel.

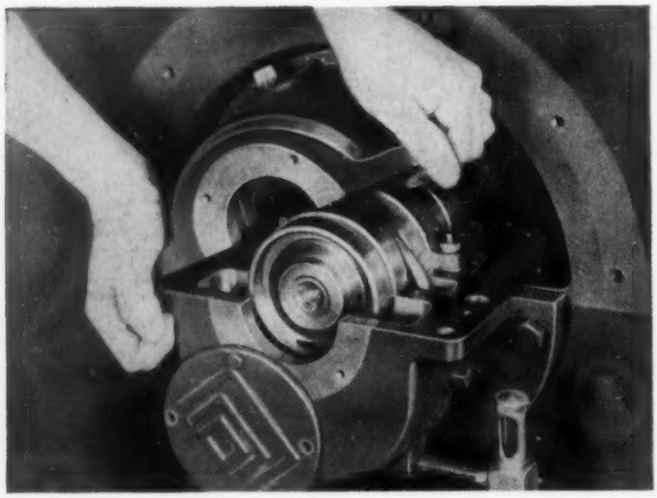
For additional information on the new 4-row tapered bore roll neck bearing, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN
TRADE-MARK REG. U.S. PAT. OFF.
TAPERED ROLLER BEARINGS

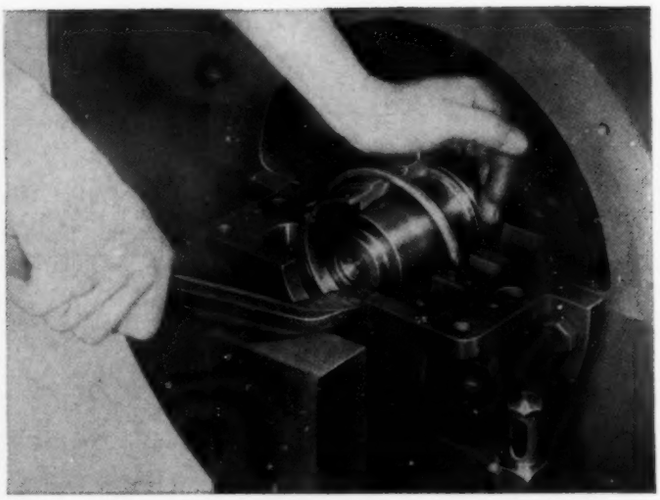
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

TO GET AT A BEARING *all you remove is the bearing cap* ...IN ELLIOTT DC MOTORS!





The bracket as well as air directing baffles stay put—you don't need to touch any part of them. The photo above shows why. As soon as you raise that bearing cap, there's the bearing, completely accessible. The top half of the bearing shell can then be lifted off.



To remove the bottom half of the bearing shell, you simply take the weight of the rotor off it, roll it round to the top of the shaft, and lift it out from under the oil ring. There's a boss on the end of the shaft to take your pinchbar. That's what it's there for—you can't hurt it.

Bracket-type design with simplified accessibility

■ As with other Elliott motors with bracket-type bearing support, in the Elliott DC line both bearings can be removed and replaced with no possibility of affecting the original alignment. It's only one of many advantages that follow Elliott "Fabri-Steel" construction which immensely broadens former engineering limitations, and gives the motor designer new freedom, unshackled by old tradition.

It's a new way to build motors, and in many plants it's cutting maintenance costs to an unprecedented degree, and supplying the brand of performance that plant managers dream about.

Write for the Elliott DC motor bulletin.

Elliott FABRI-STEEL MOTORS AND GENERATORS

ELLIOTT COMPANY

DEPARTMENT IS

RIDGWAY DIVISION • RIDGWAY, PA.

Plants at: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

MR-8

HOW DO YOU KEEP 'EM IN CHIPPING SHED IN TODAY'S MANPOWER RACE?

With every industry competing for all available workers, modernization of your billet-conditioning methods is *more than ever a MUST!*

When you install Bonnot Billetteers, you not only eliminate man-killing hand labor jobs but, also, save time — cut costs — increase production — reduce personnel turnover.

In fact, the many employers who already have taken this forward step, report all these practical gains with Bonnot Billeteering:

- Costs cut 56%.
- Better work, 10 times faster.
- Chips 100% recoverable.
- Excessive re-melting eliminated.
- Inventories reduced.
- Dependable scheduling.
- Steady flow of clean billets, ready for rolling.
- Easy operation of Billeteer.
- Super safety — 490,000 man hours with only one disabling accident.
- Workmen like the job — "gripes are out".

Let us — in terms of your plant — translate the "Billeteer Story of Savings, Safety and Schedules" providing jobs men *ASK FOR AND STAY WITH.*

Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

• Ingot of invincibility! From the hot mass of this semi-molten metal will be rolled the weapons for our national defense . . . weapons to protect the way of life we cherish. And, we hope, that the future will find the output of this soaking pit going into refrigerators, bathtubs, and structural steel for the expansion of industry and added comfort to our daily lives.

The refractories industry has kept step with the steel industry in the amazing advance of production. General Refractories has constantly increased its capacity to meet the new demands. Today it offers industry the facilities of 43 mines, 29 plants, 18 sales offices and 200 distributing agencies.

Here, in this soaking pit, you'll find

Ready to Roll!

GENERAL REFRACTORIES

GENERAL REFRACTORIES COMPANY
PHILADELPHIA

specially designed silica brick, fireclay brick, basic brick, high alumina brick, and Grefco plastic chrome ore, castables and mortars. But wherever else you look in the steel mill . . . blast furnace, open hearth, cupola . . . you'll find many another application for Grefco products.

And . . . beyond producing more and more of today's refractories products . . . General is engaged in an exhaustive research compaign to make possible even better refractories. In the world's most modern research laboratories, constant experimentation is carried on. All to the end that industry—steel, chemical, paper, glass—may count on General for a complete refractories service!

A Complete
Refractories Service

Installing and Servicing the Units in CLARK CONTROL CENTERS is as

Simple as Filing your Correspondence!

Compartments easily installed and replaced.

When changing plant layout or adding new equipment, the problem of where to place and how to set up your AC controls is greatly simplified by the use of CLARK Bulletin 6200 CONTROL CENTERS.

These neat, trim, dead-front cabinets can be set up in any straight line or right angle pattern—as convenient and accessible as the file cabinets in your office . . . When you need additional control, you can line up new sections just like adding more file cabinets . . . When machinery or equipment must be moved, the flexibility of placement and arrangement of CLARK CONTROL CENTERS makes it easy to move them along and adapt them to the new space requirements . . . When inspection, maintenance or changes are necessary, you can take out any plug-in compartment by merely removing two screws. Compartments are interchangeable . . . Where space is limited, you can use the "back-to-back" type—accommodating twice as many compartments within the same dimensions as the front-line type.

CLARK CONTROL CENTERS give you:

1. **Pan type hinged doors.**
2. **Provision for locking.**
3. **Liberal wiring space.**
4. **Accessibility of control equipment from the front.**
5. **Easily removable "plug-in" compartments.**
6. **Accommodations for combinations of starters, sizes 1 through 5.**
7. **Vertical wiring gutter 6" wide, with front-opening hinged doors.**

Consult our nearest office for further details.

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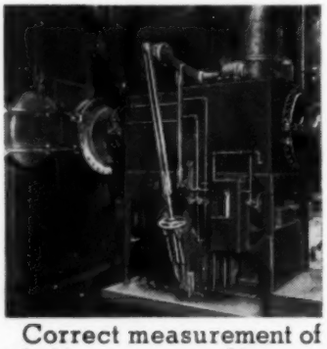

Provides proper combustion condition to develop correct temperature distribution for maximum stove heating capacity.

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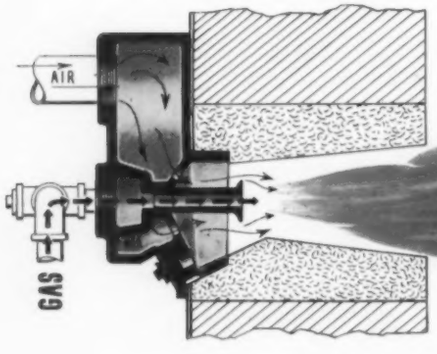

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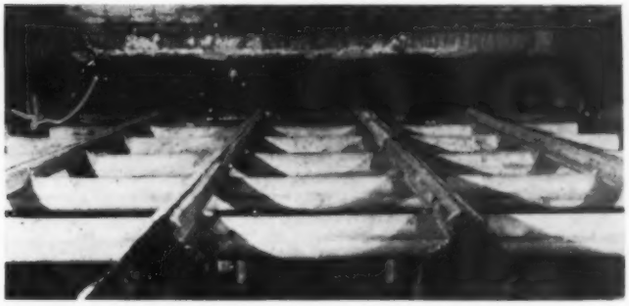
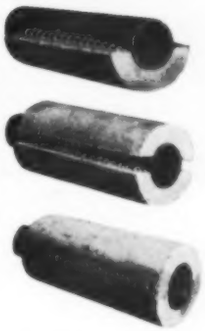
REINFORCED PIPE INSULATION

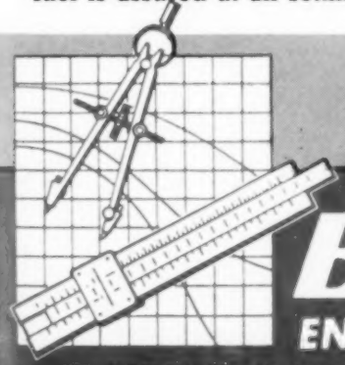


Bloom Ka-Weld Precast, Reinforced Pipe Insulation, applied to water-cooled skid pipes, risers and crossovers, reduces the heat loss to the cooling water by as much as 82% at 2400° F. furnace temperature. Steel is heated more uniformly top and bottom, skid marks are practically eliminated, there is less slag.

Ka-Weld Insulation consists of high grade refractory material, precast in convenient lengths and reinforced by a mesh of alloy steel. It is easy to install and durable.



Top—Precast lower half section is held in place by welding exposed reinforcing alloy wire mesh. Middle—Top half similarly applied. Bottom—Completed covering.



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Crops *and* Shorts

FOLLOWING the expected pattern, wage negotiations between steel producers and the United Steel Workers reached an impasse, President Truman stepped in with a no-strike request, the union's policy committee agreed and the union's convention at Atlantic City voted to postpone striking, pending a Wage Stabilization Board hearing. Phillip Murray had invited Benjamin F. Fairless to address the convention, but Mr. Fairless, to the disappointment of many, declined, stating that the union had already ridiculed his proposal that both sides forego any increase at this time, and he had nothing further to suggest.

And so the dispute goes to the Wage Stabilization Board with both sides standing pat, the union continuing to demand its original comprehensive (and expensive) package and the companies holding to its "no wage—no price increase" proposal. The guess is that everyone will eventually give somewhat, although there is a lot of public sentiment for a "freeze" both ways. The government agencies will probably find a way to bend wage and price ceilings, the union will accept a reduction in its demands, and the company will grant the reduced demands in return for a price increase. And here we go again!

▲

READING the new year columns of various columnists, we find 1951 referred to as a good year, a bad year, a year of decision, etc. Certainly, there were a lot of things going on that were bad, but we're not going profound to pontificate on that. We think 1951 was important because it was the first year that the steel industry of the United States produced more than 100,000,000 tons. The final figure will approximate 105,000,000 tons.

▲

YEAR-END statements from many equipment manufacturers and construction companies report all-time records for 1951 and look to even greater business volume and industrial activity in 1952 and future years.

▲

WE must have under-rated the intelligence of one of our good friends who, for Christmas, gave his wife a set of china so fine that she won't trust him to help with the dishes.

SENATOR HARRY F. BYRD, of Virginia, recently called attention to the fact that the Truman administration in six years has taken more ($260,000,000,000) from the American people than all the domestic taxes collected ($248,000,000,000) in the previous 156 years of our country's life. Senator Byrd recommends immediate and continued protests to members of Congress on unessential spending.

▲

ADD to the effects of television upon our habits: Before World War II 65 per cent of liquor sales were made in taverns. Now, 65-70 per cent are said to be made in package stores for home consumption. And the sports promoters and purveyors of entertainment can move down on the mourners' bench to make room for the tavern keeper.

▲

WE are disturbed occasionally when readers call or write regarding errors that crop up in some of our published material. And so it's comforting to find that our contemporaries aren't perfect either. One magazine recently carried a story on electric arc furnaces which contained the startling (even revolutionary) subhead: "Power Use Eliminated." A brief item in another magazine contained some arithmetical miracles in giving the capacity of a continuous casting unit as 1000 tons per day, with monthly production averaging 750-1000 tons and daily production of 175 tons at a rate of 20 tons per hour or 3 heats (10,000-15,000 lb per heat) per day.

We're not gloating, but misery does love company.

▲

MAYBE that Key West restaurant man who says the coffee cup Truman used when he stopped in recently will never be washed is saving the soap for some other things associated with the administration that need it more.

▲

AN item in Printers Ink criticizes on the grounds that they are too general, the many statements appearing in the public print decrying the drop-off in standards of public and private morality. Diagnosing the trouble as "fast-buck fever," the article recommends a simple remedy: "Keep free personally of the malady" — and that makes a lot of sense. The public is becoming cynical and is inclined to jest at law violation. Amoral incidents are too often treated with indifference or tossed off with a wisecrack. And so the incidents become more frequent and more serious to the point of scandal. It's high time that we act to stop this trend, and we agree that the best way to do this is for each one of us to keep free of fast-buck fever.

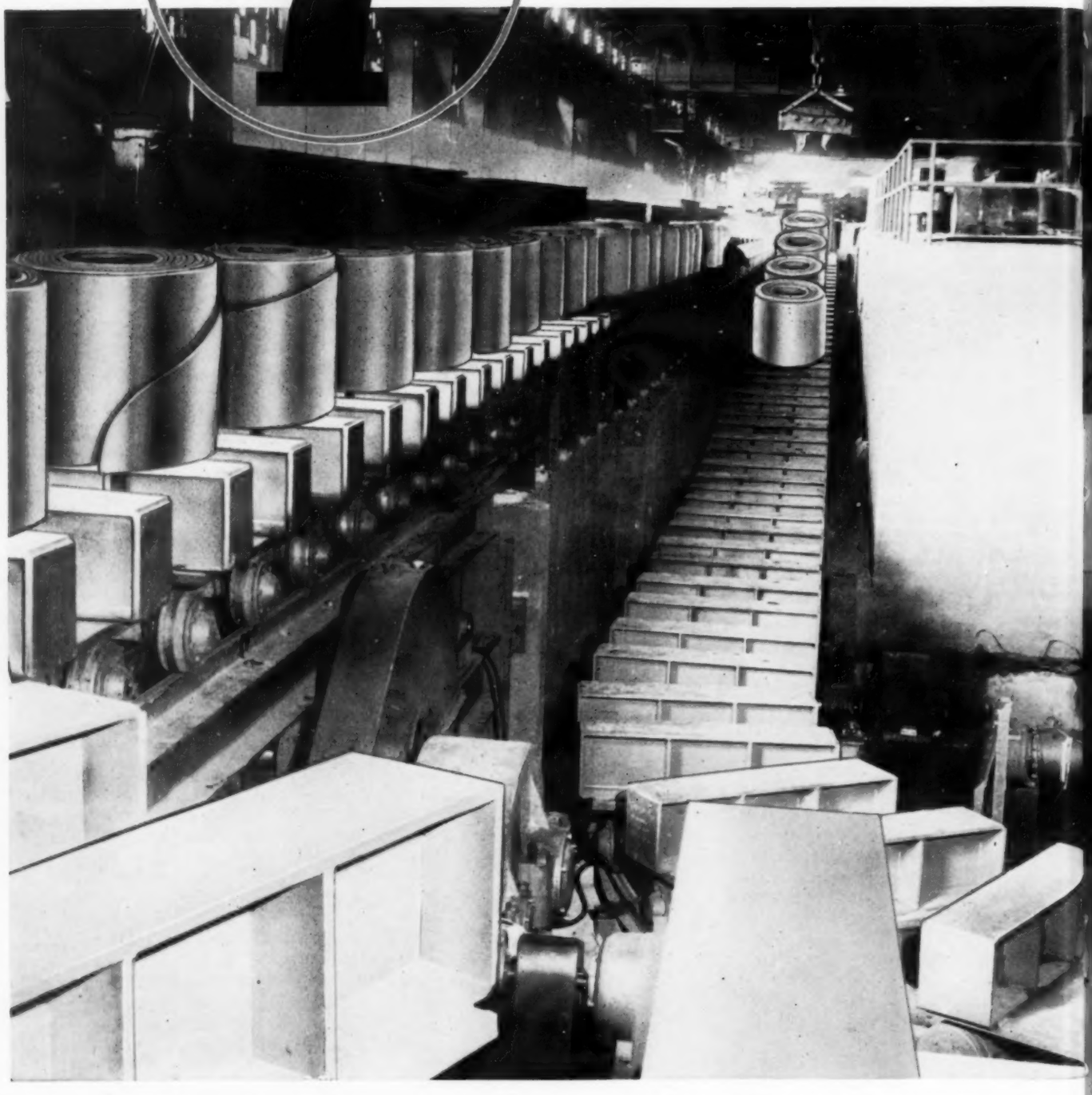
▲

WE have heard that bread cast upon the waters will return some day. Maybe we ought to bake that dough we cast across the ocean, just to be on the safe side.

▲

ONE of our friends tells us that the radio slogan heard so often, LSMFT, doesn't really mean "Lord, save me from Truman."

7 WAYS TO

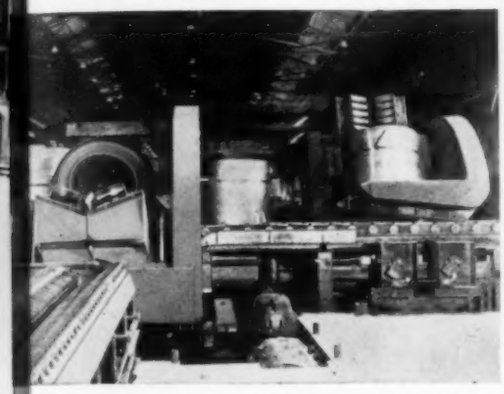


1 Along every step of the way—in every process—Link-Belt can help you cut costs with modern materials handling machinery. See a typical example, above. Here, Link-Belt Car-Type Conveyors economically move coils of hot strip around corners and down inclines—all without rolling or scuffing edges.

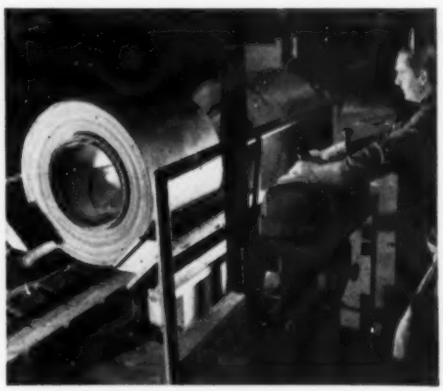
Link-Belt is materials handling headquarters. Working hand-in-hand with your own engineers, consultants, and builders of mill and process equipment, Link-Belt engineers can help you solve your mechanization problems. Write direct or contact your nearest Link-Belt representative.

GREATER YIELD

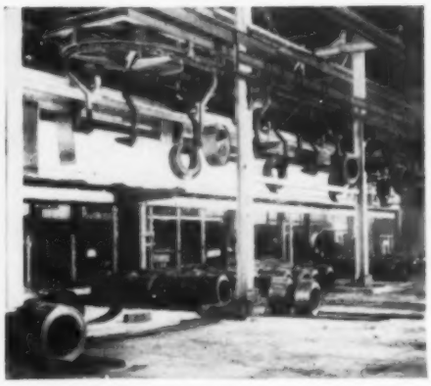
LINK-BELT can help you increase output in your present plant with modern mechanization



2 Greater yield comes from gentler handling. Link-Belt Down-Tilters and Transfers are designed to provide smooth, controlled manipulation of hot coils and increase mill yield by reducing scrap.



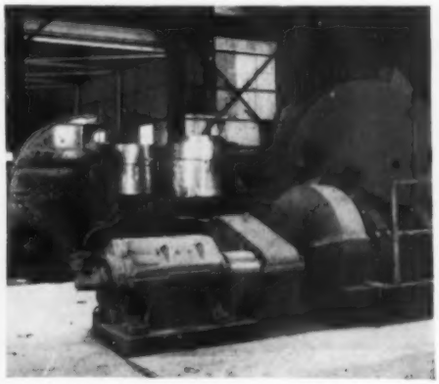
3 Link-Belt Conveyors provide controlled storage ahead of pickle lines, cold mills and other processes. This is essential for scheduling and to eliminate the confusion of vehicles and the hazard of overhead cranes.



4 Link-Belt Overhead Trolley Conveyors create added work-area on floors of existing plants — are readily adaptable to irregular paths and building structures for carrying and cooling coils of narrow strip, rod and wire.

5 Link-Belt can step up your raw materials storage and handling operations — permit the storing of more materials in the same area ... storing at higher tonnage rates ... reclaiming at increased handling rates.

6 Specially developed Link-Belt Chains take brutal punishment year after year in the nation's steel mills. Standard types are available for basic elements of complete handling systems or power transmission.



7 Link-Belt Herringbone Gear Drives are engineered to take heavy shock loads dependably and continuously. Yes — wherever power is to be transmitted mechanically, Link-Belt offers a full range of gear and chain drives.

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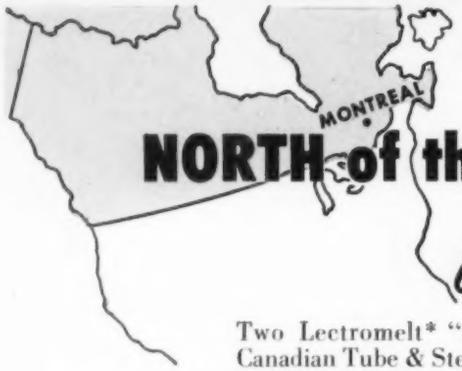

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

ROLLING CHARACTERISTICS OF VARIOUS STEELS

. . . . apparently alloying elements do not have as powerful an effect on steel properties at rolling temperatures as they do at room temperatures . . . . rolling qualities are very difficult to predict . . . .

By EDGAR M. D. HEROLD

Superintendent Finishing Mills

Crucible Steel Co. of America

Midland, Pa.

▲ THE word steel to the average person means a very common metal from which is manufactured hundreds of articles used in his every day life. We, as steel men, however, realize that this word steel encompasses a multitude of metals which have identities of their own, a good many of which must be treated very carefully if we are to obtain the desired result in the finished product.

The metallurgists, striving for better performance of the finished product, are constantly experimenting with different alloys in varying amounts. Since the functions of alloying elements are to impart desired properties to the steel and since these elements apparently affect the rolling characteristics of the metal, it is fitting that we set forth some of the effects obtained from alloying elements.

Carbon—Carbon is not generally considered an alloy in respect to steel, but its properties should be considered since it plays a very important part in the chemistry and rolling characteristics of most steels. Within definite limits, increased carbon produces the following effects in steel:

1. Raises the ultimate strength.
2. Lowers ductility and toughness.
3. Reduces resistance to shock.
4. Increases wear resistance and resistance to machinability.
5. Increases susceptibility to decarburization.

Manganese—Some of the effects of increased amounts of this element are as follows:

1. Raises ultimate strength and toughness.
2. Increases the rollability of steel; that is, it tends to make the steel more malleable at a given temperature.
3. Decreases heat conductivity and thus increases time for steel to become heated through to the required rolling temperature.

Silicon—The following are some of the results obtained by additions of silicon:

1. Raises the ultimate strength when content is not over 2.5 per cent. Additions over 2.5 per cent increase brittleness and when silicon content is over 5 0 per cent, the steel becomes non-rollable.
2. Increase brittleness in high carbon steels.
3. In conjunction with chrome and nickel increases rollability of steel.
4. Has a tendency to induce decarburization when over 0.5 per cent.

Nickel—Some of the results obtained from increased amounts of nickel are:

1. Raises the ultimate strength and increases resistance to shock.
2. Increases resistance to chemical attack at atmospheric temperature and in combination with chrome resists oxidation and corrosion at high temperatures.
3. Enhances the effects of other alloys. The combination of nickel-chrome alloys imparts properties to steel that neither one of the alloys can do singly.

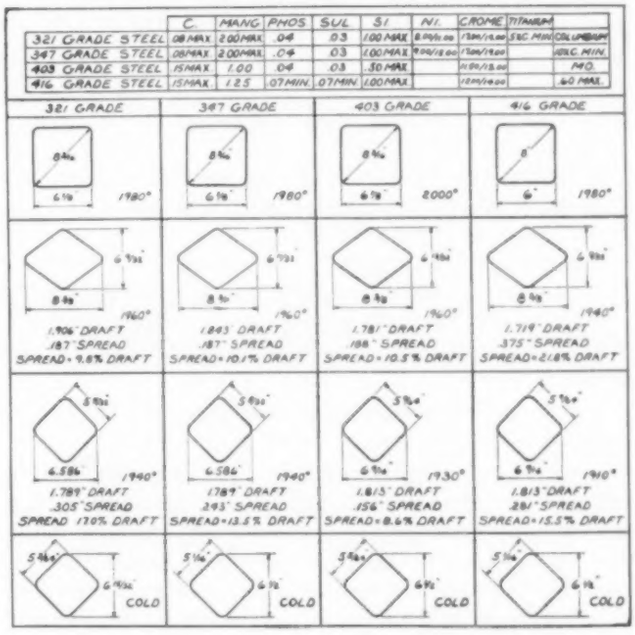
Chrome—Some of the results obtained from additions of this alloy are:

1. Increases resistance to deformation and abrasion.
2. Raises the ultimate strength, hardness and toughness of the steel.
3. Makes possible a lowering of the carbon content. A given carbon content with addition of chrome has a much greater hardening effect than the same carbon content in a carbon steel.
4. Raises thermal conductivity.
5. Increases resistance to chemical attack.

Molybdenum—Some results obtained from the addition of molybdenum are:

1. Increased hardness and toughness.
2. Tendency to retain hardness of steel at rolling temperatures.

Figure 1 — Sequence for rolling 5-in. squares from 321, 347, 403 and 416 grade steels.



Vanadium—Some of the effects produced by the addition of vanadium are:

1. Increased resistance to shock.
2. Increased ultimate strength.
3. Tends to enhance the properties of the other alloying elements in steel.
4. Better enables the steel to withstand long heating cycles.

Tungsten—Some of the effects obtained from the addition of this alloy are as follows:

1. Raises the toughness, strength and hardness of the steel.
2. Decreases the plasticity of steel at rolling temperatures.

Cobalt—The following are some of the results obtained from the addition of cobalt:

1. Enhances the properties of other alloying elements.
2. Increases density and strength.
3. Tends to resist oxidation and corrosion at high temperatures.
4. Decreases plasticity at rolling temperature.

It is not the purpose of this paper to explain the metallurgical or chemical reasons for the various characteristics encountered in the rolling of different steels, but rather to set forth their peculiarities from the viewpoint of rolling. Although the spread encountered in rolling is caused by numerous factors such as temperature, friction between rolls and the metal being rolled, shape of the contact area, analysis of the metal being rolled, speed of rolling, etc., these factors except temperature and analysis of the material being rolled were discounted in the examples used in this paper. The reason for disregarding these other pertinent factors is that the various sets of examples to be shown were taken on the same mill, rolled in the same rolls, same shape passes, same rolling speeds, etc. Furthermore, it is not our intent to delve into the theory and mechanics of rolling. The sole purpose is to show the results obtained and the manner in which various grades of steel act between rolls when heated and rolled into round and square merchant bars. An attempt will be made to show how varying percentages of the before mentioned alloys affect the heating and rolling of these grades. It is realized that numerous questions will be left unanswered. As a matter of fact, practically no questions will be answered nor problems settled but there may be some food for thought for the metallurgists and perhaps at a future date these problems can be satisfactorily resolved.

The first examples to be shown were taken from rollings on a 24-in. three stand reversing bar mill. The bloom is given the necessary number of passes in the roughing stand to produce the cross section desired and then one pass in the leader and one pass in the finisher completes the bar. The samples in this mill were taken from the last pass in the rougher, the leader and the finishing pass.

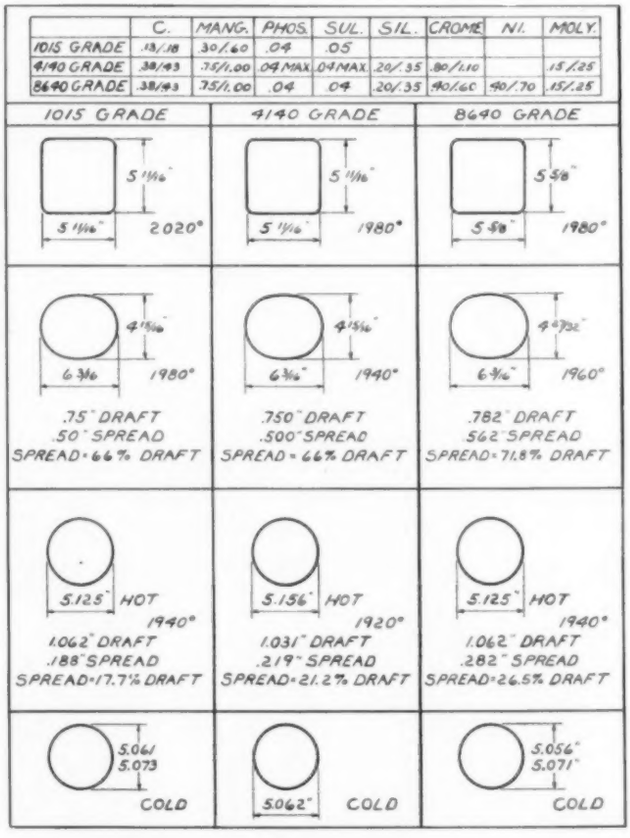
Figure 1 shows 5-in. squares rolled from 416, 403, 321 and 347 grades.

It will be noted that a $6\frac{1}{8}$-in. square is used for the 347 and 321 grades which makes a $3\frac{3}{8} \times 6\frac{11}{32}$ in. and $8\frac{3}{8} \times 6\frac{9}{32}$ in. diamond respectively. Both of these diamonds make a $5\frac{5}{32}$ in. square hot, in the finishing pass. Both grades were identical in temperature. The spread in relation to the draft is greater in the diamond pass on the 347 grade than the 321 grade, while just the reverse is true in the square pass. It will be noted that these grades shrink differently. The 321 grade shrunk to 5.046 in. at approximately 45 F atmospheric temperature while the 347 grade shrunk to 5.062 in. The 347 grade shrunk 0.094 in. while cooling 1895 F or at a rate of 0.0000485 in. per degree while the 321 grade shrunk 0.110 in. while cooling 1895 F or at a rate of 0.0000580 in. per degree.

The 403 and 416 grades behave the way you would normally expect if the alloying elements impart their properties to steel in the hot state. The 416 grade contains more manganese, silicon and chrome than the 403 and in both the diamond and square pass, the 416 grade apparently resists compression to a greater degree than the 403 and spreads more in relation to the draft. These two grades shrunk at a rate of 0.0000332 in. per degree for the 403 grade and 0.0000417 in. for the 416 grade.

The 347 grade shown in this illustration is a good example of a steel that may be rolled successfully on one mill and be a complete failure on another mill. This steel can be rolled with little difficulty on the 24 in. mill previously mentioned where the steel is broken down in box passes and then given one diamond pass and one square pass. When this grade was further reduced on another mill which has a three-high 18-in. rougher and pony rougher with diamond and square passes, it cracked on the corners in the roughing passes and could not be used when rolled down to $1\frac{17}{32}$-in. rounds. The cause of the cracking apparently is the spread of the steel which resulted in thin corners which cooled rapidly. With fixed drafts on a three high mill it is extremely

Figure 2 — Sequence of rolling 5-in. rounds from 1015, 4140 and 8640 grade steels.



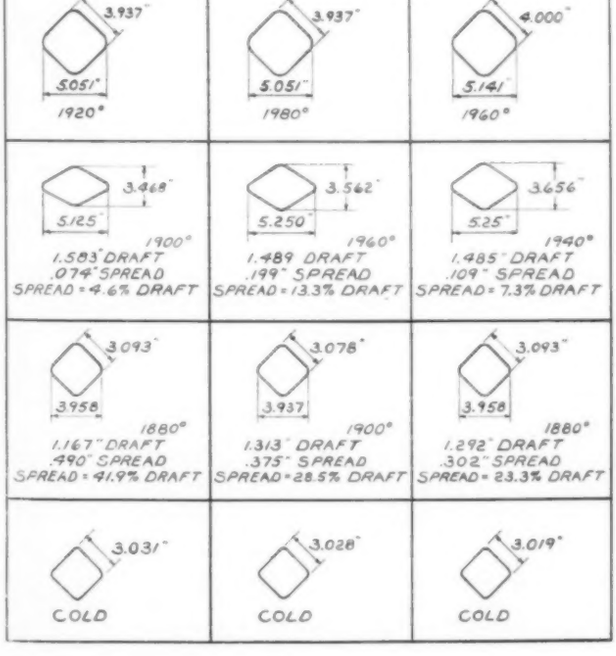
difficult to adjust for the spreads encountered in such a grade unless special rolls are turned.

In this particular instance special rolls were not turned. This steel could be observed cracking in the roughing passes. We tried increasing the temperature to the point where we burned the end of two billets but to no avail. The billets still spread and cracked on the corners. The billets were 4 × 4 in. and had approximately $\frac{5}{8}$ in. corner radii. It was felt that if we made the billet corners larger we might cut down on some of the spread and eliminate the cracking. Subsequently, we took nine billets remaining from the same heat and ground 1 in. chamfered corners on them. There was some improvement in these bars when rolled but not enough to make this method commercially sound.

Figure 2 shows 5-in. rounds rolled from 1015, 4140 and 8640 grades. These grades for the most part seem to follow the pattern you would normally expect. On the 1015 grade, the oval spreads 66 per cent of the draft. The same holds true for the 4140 which, however, with increased carbon and the addition of chrome and molybdenum you might expect to spread more. The 8640 grade, spreading 71.8 per cent of the draft in the oval pass, again falls into the expected pattern. In the round pass the relation of spread to draft follows according to the increase in alloying elements. The rate of shrinkage of these three grades is practically the same.

Figure 3 shows 3-in. squares rolled from 1095, 4340 and 308 grades. Here again the spreading does not follow a pattern that you would expect from the analysis and temperatures. You will note that a 3.937-in. square is used for both 308 and 4340 and that the cold

Figure 3 — Sequence of rolling 3-in. squares from 308, 4340 and 1095 grade steels.



sizes are the same within 0.003 in., yet there is a considerable difference in the stock of the diamonds and hot squares. When these samples were rolled the atmospheric temperature was approximately 50 F. The rate of shrinkage on these grades was 0.000025 in. per degree for 4340, 0.0000404 in. per degree for 1095 and 0.0000338 in. per degree for 308. These shrinkage rates of course are not absolutely perfect since the temperatures were taken with an optical pyrometer, but it can be seen that there is a difference in shrinkage rates in various grades of steel. Sometimes these shrinkage rates can play an important part, particularly when a close tolerance bar is desired.

Since the prescribed subject of this paper is rolling characteristics of various grades of steel, the author has dealt solely with the relation of draft to spread or the action of the steel between the rolls. Since the illustrations shown were rolled on the same rolls at the same rpm the various actions of the steels can be attributed to the steel proper rather than to any mechanical action.

TABLE I

Pass	Rpm	Effective diam, in. 5-in. square	Effective diam, in. 5-in. round	Effective diam, in. 3-in. square
Rghr	120	20.250	20.250	22.500
Ldr	120	22.918	22.882	23.630
Fin	120	22.966	23.050	23.790

The effective roll diameters and speeds of the 3 sizes rolled on the 24-in. mill are shown in Table I.

It has been assumed that the steel was properly heated for rolling and it is not the writer's intention to go into detail concerning the necessary heating practices. The heating of various grades of steel for merchant bar rolling would be a subject for a paper in itself. It is fitting, however, to discuss the heating and rolling of two grades of steel, not illustrated, that can be troublesome.

We know that nickel steels are hard to roll and produce a good surface. Nickel with its affinity for sulphur produces a sticky scale and pitted condition on the steel that is bad for the ultimate finished product. The 3310 and 9 per cent nickel grades are two good examples of these steels.

The analysis of 9 per cent nickel is:

C	Mn	P	S	Si	Ni	Cr
0.09	0.42	0.01	0.022	0.29	8.70	0.13

Three-inch rounds of this grade are rolled from 8 × 7-in. blooms. The blooms are preheated in a continuous furnace to approximately 1800 F. The steel is transferred to batch type furnaces with bottoms somewhat over 2100 F. The steel is brought up to 2275 F in one hour with frequent reversals and damper periods. The steel is then heated rapidly, a flash heat, to 2325 F in 15 minutes and rolled. It is important that this time not be exceeded to prevent the formation of heavy scale. With this practice the temperature after the first pass is 2100 to 2160 F. The flash heat during the last 15 minutes tends to expand the surface of the steel greater than the center and thus the scale is loosened.

Hydraulic sprays are used on the entry and delivery side of the leader rolls and on the entry side of the finishing rolls. An absolute minimum amount of water for neck bearings is used and no water is used on the

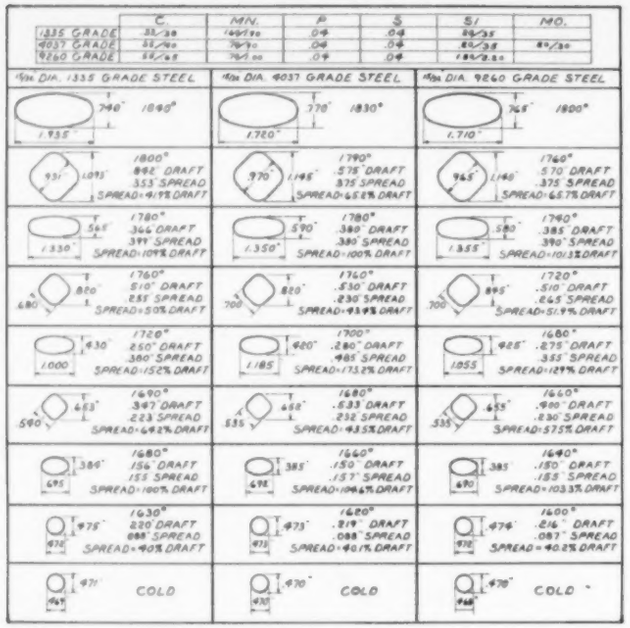

C MN. P S SI MO.
1335 GRADE .33/.38 1.60/1.90 .04 .04 .20/.35 .20/.30
4037 GRADE .35/.40 .70/.90 .04 .04 .20/.35 .20/.30
9260 GRADE .56/.65 .75/1.00 .04 .04 1.80/2.20
15/32 DIA. 1335 GRADE STEEL
15/32 DIA. 4037 GRADE STEEL
15/32 DIA. 9260 GRADE STEEL
.740" 1840°
1.935"
.770" 1830°
1.720"
.745" 1800°
1.710"
1800° .892" DRAFT .353" SPREAD SPREAD=41.9% DRAFT
1790° .575" DRAFT .375" SPREAD SPREAD=65.2% DRAFT
1740° .570" DRAFT .375" SPREAD SPREAD=65.7% DRAFT
1780° .344" DRAFT .399" SPREAD SPREAD=109% DRAFT
1780° .380" DRAFT .380" SPREAD SPREAD=100% DRAFT
1740° .385" DRAFT .390" SPREAD SPREAD=101.3% DRAFT
1760° .510" DRAFT .255" SPREAD SPREAD=50% DRAFT
1760° .530" DRAFT .230" SPREAD SPREAD=43.4% DRAFT
1720° .810" DRAFT .845" SPREAD SPREAD=51.9% DRAFT
1720° .250" DRAFT .380" SPREAD SPREAD=152% DRAFT
1700° .280" DRAFT .485" SPREAD SPREAD=173.2% DRAFT
1680° .275" DRAFT .353" SPREAD SPREAD=128% DRAFT
1690° .347" DRAFT .223" SPREAD SPREAD=64.2% DRAFT
1680° .533" DRAFT .232" SPREAD SPREAD=43.5% DRAFT
1660° .900" DRAFT .230" SPREAD SPREAD=57.5% DRAFT
1680° .154" DRAFT .155" SPREAD SPREAD=100% DRAFT
1660° .150" DRAFT .157" SPREAD SPREAD=104.6% DRAFT
1690° .150" DRAFT .155" SPREAD SPREAD=103.3% DRAFT
1630° .220" DRAFT .088" SPREAD SPREAD=40% DRAFT
1620° .219" DRAFT .088" SPREAD SPREAD=40.1% DRAFT
1600° .216" DRAFT .087" SPREAD SPREAD=40.2% DRAFT
COLD
COLD
COLD

Figure 4 — Sequence of rolling 15/32-in. rounds from 1335, 4037 and 9260 grade steels.

roll passes. The water is, however, turned on between blooms. The heating practice and hydraulic sprays eliminate almost all rolled in scale, surface shatter and pits. The elimination of water on the pass tends to eliminate the fine cracks that are encountered in this grade which is extremely detrimental to the piercing operation on tubes.

The percentage analysis of 3310 grade steel is:

C	Mn	P	S
0.08/0.13	0.45/0.60	0.025	0.025

Si	Ni	Cr
0.20/0.35	3.25/3.75	1.40/1.75

This steel is rolled into 0.883-in. rounds from a 4 × 4-in. billet. The first two stands of this mill are three high cross country and the last five stands are two high cross country. The furnaces are batch type, but there is no preheating furnace. The billets are charged two doors behind the draw; that is, No. 2 door is charged when No. 4 door is drawn, No. 1 door is charged when No. 3 door is drawn. The gas is cut off on the charging end of the furnace during charging. The steel is brought up to 2250 F in one hour with frequent reversals and dampering periods. It is then heated rapidly to 2325 F in fifteen minutes and rolled. This steel should not be held in the furnace any longer than it takes to bring up to temperature. A first pass temperature of 2120 to 2160 F is aimed for. Hydraulic sprays are used ahead of the rougher and on the entry side of the fifth stand. Compressed air sprays are used at the entry to the third stand and at the delivery of the sixth or leader stand. Water is kept at a bare minimum on all stands. This practice virtually eliminates rolled in scale, pits, shatter, etc.

Going from the ridiculous to the sublime as far as scale removal is concerned silicon-chrome steel might be mentioned. This grade is a valve steel and does not have an AISI nor SAE number.

The analysis is as follows:

C	Mn	P	S
0.35/0.45	0.25/40	0.03 max	0.04 max

Si	Ni	Cr	Mo
3.60/4.20	0.25 max	1.85/2.50	0.10 max

This steel is very free scaling. No precautions whatever have to be taken and the scale just falls off in every pass.

The sizes and grades to be discussed next were rolled on an 8-12-14-18-in. mill. This mill has two stands of 18-in. continuous roughing, followed by six stands of 14-in. continuous roughing, then two stands of 14-in. cross country, which in turn are followed by four stands of 12-in. looping. From the 12-in. outlet the bar is delivered to the hot bed or to the coilers or it can be looped into two stands of 8-in. looping. The 8-in. stand delivers to either the hot bed or to the coilers. This mill is serviced by two continuous furnaces.

The samples to be illustrated were taken from the first cross country stand through the finishing stand on either the 12 in. mill or 8 in. mill outlets.

Figure 4 shows 15/32-in. rounds rolled from 1335, 4037 and 9260 grades. These grades are manganese steel,

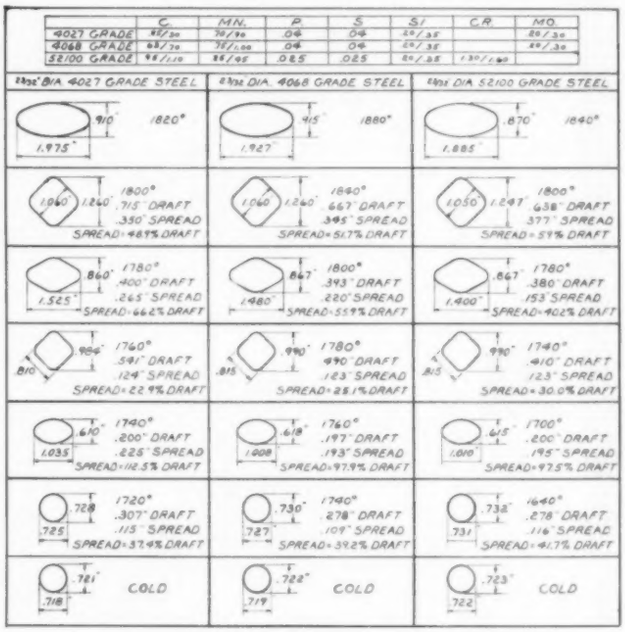

C MN. P S SI C.R. MO.
4027 GRADE .25/.30 .70/.90 .04 .04 .20/.35 .20/.30
4068 GRADE .65/.70 .75/1.00 .04 .04 .20/.35 .20/.30
52100 GRADE .98/1.10 .35/.45 .025 .025 .20/.35 1.30/1.60
23/32 DIA. 4027 GRADE STEEL
23/32 DIA. 4068 GRADE STEEL
23/32 DIA. 52100 GRADE STEEL
.910" 1820°
1.975"
.915" 1880°
1.927"
.870" 1840°
1.885"
1800° .715" DRAFT .350" SPREAD SPREAD=48.9% DRAFT
1840° .667" DRAFT .395" SPREAD SPREAD=51.7% DRAFT
1800° .638" DRAFT .377" SPREAD SPREAD=59% DRAFT
1780° .400" DRAFT .265" SPREAD SPREAD=66.2% DRAFT
1800° .393" DRAFT .220" SPREAD SPREAD=55.9% DRAFT
1780° .380" DRAFT .153" SPREAD SPREAD=40.2% DRAFT
1740° .591" DRAFT .124" SPREAD SPREAD=22.9% DRAFT
1780° .490" DRAFT .123" SPREAD SPREAD=25.1% DRAFT
1740° .410" DRAFT .123" SPREAD SPREAD=30.0% DRAFT
1740° .200" DRAFT .225" SPREAD SPREAD=112.5% DRAFT
1760° .197" DRAFT .193" SPREAD SPREAD=97.9% DRAFT
1700° .200" DRAFT .195" SPREAD SPREAD=97.5% DRAFT
1720° .307" DRAFT .115" SPREAD SPREAD=37.4% DRAFT
1740° .278" DRAFT .109" SPREAD SPREAD=39.2% DRAFT
1640° .278" DRAFT .116" SPREAD SPREAD=41.7% DRAFT
COLD
COLD
COLD

Figure 5 — Sequence of rolling 23/32-in. rounds from 4027, 4068 and 52100 grade steels.

molybdenum steel and silicon-manganese steel respectively. There does not seem to be any definite pattern nor relation between alloying elements and the action of these steels. There is considerable spread in the oval passes, but the percentage of draft going into spread does not hold to any definite pattern.

The 9260 grade, silicomanganese, shown in Figure 4 is a good example of a steel that is prone to decarburize in the heating furnace. While decarburization has little effect on the rolling characteristics, this steel is usually rolled quite cool which does effect its characteristics. The steel illustrated is heated in an end discharge continuous furnace and is rolled as cold as practical to reduce decarburization.

If for any reason, pass changes, guide changes, etc., the rolling must be stopped, the billets are rolled off the furnace hearth for a distance of approximately 10 ft-0 in. This procedure keeps the billets back from

the open front end of the furnace and reduces, but of course does not eliminate decarburization.

A point concerning decarburization to keep in mind, and one that is quite frequently forgotten, is that the depth of decarburization of the finished bar is a function of billet size in relation to the area of the finished product. Some mills must use a constant billet size for most products.

The mill on which the sizes shown in Figure 4 were rolled is an example of this. Rounds from 0.370 to 1.000 in. are rolled on this mill from a 4 × 4-in. billet. If the best that can possibly be done with a 4 × 4-in. billet is 1/16-in. decarburization, this must be kept in mind in relation to the area of the finished bar.

As an illustration, we will take a 1/2-in. round rolled from a 4 × 4 in. × 11 ft-0 in. billet whose surface has been decarburized to a depth of 1/16 in. The billet would contain 118.58 cu in. of decarburization. The 1/2-in. round rolled from this billet if rolled in one continuous piece would be 9862 in. long. The volume of decarburization, 118.58 cu in., divided by 9862 in., length of the finished bar, equals 0.012 sq in. of decarburization on the 1/2-in. round. Since the circumference of a 1/2-in. round is 1.57 in. this shows an approximate depth of decarburization of 0.007 in. on the finished bar. If a 7/8-in. round is to be rolled from this same size billet and 1/16-in. depth of decarburization is the best that can be obtained in the furnace, the depth of decarburization on this finished round would be 0.013 in.

Figure 5 shows 23/32-in. rounds rolled from 4027, 4068 and 52100 steels.

These steels contain 0.25/0.30, 0.64/0.72 and 0.95/1.10 per cent carbon respectively. The action of these three steels seems to be similar despite the variation in carbon content. It may be that the increased manganese in the 4068 grade tends to balance the carbon and make the 4027 and 4068 grades work similarly but with 0.95/1.10 carbon and 1.30/1.60 chrome and the manganese dropped to 0.25/0.45 in the 52100 grade, the writer cannot answer why this grade follows so closely to the 4027 and 4068 grades.

Figure 6 shows 9/16-in. rounds rolled from 9260, 51100 and 52100 grades. Here again as we have seen in most samples there does not seem to be any definite pattern in relation to the steel analysis. Since all samples shown were rolled on the same passes, at the same speeds, etc., as has been stated before, the reasons for the various actions can be construed as being solely die analysis and temperature, but when these actions are not constant nor similar, that is one grade spreads more in relation to the draft than another grade in No. 9 stand but less in No. 11 stand, the writer certainly is at a loss to know how to explain these actions. From the samples shown, we can readily raise the question, "Do alloying elements impart their properties to steel at rolling temperature?"

It is the writer's opinion, and only an opinion since he cannot prove so, that the alloying elements which we have been discussing are not as powerful in their effect, or rather the properties they impart to steel at rolling temperatures as they are at room temperature, and furthermore, the properties they do impart are not consistent through the temperature range from 2000 to 1600 F. Above the transformation point we might normally expect the alloys to begin showing their properties in a straight line curve from 2000 to 1600 F and perhaps lower but it is not felt that this is the case.

Figure 6 — Sequence of rolling 9/16-in. rounds from 9260, 51100 and 52100 grade steels.

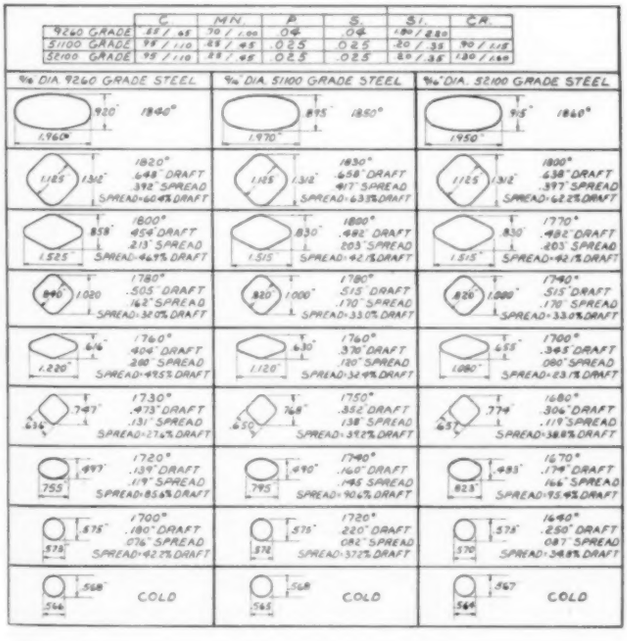


TABLE II

Stand	Rpm	Effective diam, in.	Effective diam, in.	Effective diam, in.
		15/32	9/16	23/32
8	200.00	14.148	14.070	14.096
9	274.96	12.375	12.298	12.012
10	274.96	12.258	12.180	12.180
11	274.96	12.352	12.324	12.804
12	274.96	12.284	12.252	12.732
13	552.00	7.878	7.840	.....
14	552.00	8.820	8.784	.....

Table II shows speeds and effective diameters of the rolls used for rolling the samples shown in Figures 4, 5 and 6.

In the sections illustrated, two mills and 17 different grades of steel have been covered. The range of steels has run from the commonest carbon steel to some of the fancier grades of stainless steels. All of the examples that have been shown were taken from commercial rollings, no attempt having been made to set the mills for test purposes.

We have seen that various grades spread differently an although heating has not been discussed too much, it must be realized that there are numerous heating practices covering these grades.

This paper does not contain enough data to make any definite statements concerning the rolling characteristics of various grades of steel. We have shown how these steels act on specific mills, but can make no definite claim that they will act in the same manner when rolled on other mills. From the information at hand, no definite statements can be made concerning the behavior of the alloying elements in steel.

It is hoped that those who have not experienced rolling these various grades may have gathered a few

pointers to assist them should they be called upon to roll these steels and to those that are currently rolling such grades it is hoped that this paper may help as a check on the behavior of steels in their own plants.

DISCUSSION

PRESENTED BY

W. T. FIELDS, Superintendent Roll Shop, United States Steel Co., Duquesne, Penna.

LOUIS MOSES, Superintendent Rail Mill and Roll Shop, Bethlehem Steel Co., Sparrows Point, Md.

JAMES T. O'BRIEN, Works Manager-Steel Division, Firth Sterling Steel & Carbide Corp., McKeesport, Penna.

EDGAR M. D. HEROLD, Superintendent Finishing Mills, Crucible Steel Co. of America, Midland, Penna.

CHARLES P. HAMMOND, General Superintendent, Greenriver Steel Corp., Owensboro, Ky.

A. M. CAMERON, Superintendent Rolling Mills, Atlas Steels Ltd., Welland, Ontario, Canada.

LEWIS C. SOWELL, Superintendent Blooming and Rolling Mills, Jones & Laughlin Steel Corp., Aliquippa, Penna.

W. T. Fields: The author has presented many problems in the rolling of alloy steels. Quite a few of these, I believe, are not only rolling problems, but are plant problems as a whole; melting, rolling, finishing and heat treating.

Probably many of our difficulties in the rolling of these steels stem from our reluctance to change to more suitable rolling methods. To those who are engaged mainly in the rolling of carbon steel, changes in rolling methods to accommodate alloy steels sometimes involve relatively heavy capital expenditures for a minor portion of the product. We therefore place much emphasis on precise heating methods, and more precise control of rolling temperatures.

Certainly there is still a great deal of study which can be made along the lines so ably presented by the author to further our knowledge of the behavior of these steels in the rolling process.

Louis Moses: We cannot but admire this splendid work on attempting to run down predictable patterns of behavior among the several grades of steels.

Practically all of this commentator's experience has been with carbon steels and these alone exhibit variations enough. We are mostly familiar with the characteristics of behavior of bessemer and open hearth grades, rail passes for one of them, for instance, not being at all workable for the other; with mill settings varying between the open and killed grades, etc.

The metallurgist tells us about the different space lattices of steels and how at varying stages of transition in heat treatment from the austenitic to martinsitic, the interstices between the molecules present varying structures and grain arrangement, etc. Now, it occurs that related phenomena are also responsible for the ability of one kind of steel to spread under rolling action when another kind of alloy will not.

It occurs also that the input of power to a mill may be a measure of this. There is the case where power considerations severely limited the rolling of strip to a comparatively narrow width of 24 in. to 30 in. Zealously watched by the electrical staff, they first had the impression that the mill violated orders as was evident from the upswing of the meters. It developed that rephosphorized steel was being rolled within the prescribed width. In another case, a three stranding rod mill was having some difficulties with driving gears. Under the former and general practice of rolling two strands, the rolling of a 2.00 per cent mg, high carbon steel had offered no difficulty whatever. When applied to three stranding, the gearing promptly folded up and rollings of the grade were restricted to two stranding.

Both instances, admittedly form very inadequate data in comparison with the painstaking work of the paper, but nevertheless reflect variations in the compressive rates of deformation. The point is that very probably the same kind of measurements applied to the various alloys would form some pattern.

To this is added the question of plasticity at rolling temperature. The author tells about cracked corners occurring on some and not with the carbon grades. The amount of work allowable became a criterion on whether the bar would get through the mill without damage, as understood from the text. We know the difference between rolling wrought iron and carbon steel where the approximately 20 per cent of lessened work of wrought iron is explained by its structure containing slag. In a purely questioning manner could it be that some of our alloy steels have the characteristic of their grains not sticking tightly together at elevated temperatures despite their value in physicals when at room temperature?

James T. O'Brien: In this paper, the author has described experiences in rolling AISI 416 which parallel our experiences. We have noticed, however, that the tearing at the corners which he describes occurs in the original roughing passes. We use a series of 98 degree round cornered squares to rough down from the ingot stage with about a 10 per cent draft in each pass. We have noticed that if we remove the tears that occur in this stage by conditioning, and keep the steel reasonably hot, that we have no more trouble with corner tearing.

We use essentially the same passes in reducing the bar after conditioning as those used before conditioning so we cannot attribute the corner tearing entirely to the pass design. Possibly the tearing is the result of an inherent weakness of this grade of steel in the as cast condition.

E. M. D. Herold: I believe your experience is somewhat similar to ours although the grade I mentioned concerning tearing particularly was 347. I think that when you first shape the square bloom or billet in the 98 degree round cornered square pass, you may get some cooling action in the corners in the first pass that may tend to crack the bar. It is quite possible from the first or second pass on, you have rounded up the corners and with a 10 per cent draft you do not get enough spread to make the corners formed in the parting of the rolls small enough to lose heat to the point that they crack. This I believe would hold true in sub-

sequent rolling in the same shape pass and same drafts after the tears had been conditioned.

I think the light drafts and a generous corner radius is the reason for little or no tearing.

Charles P. Hammond: On grades of stainless that have a tendency to check on the corners during the rolling operation, the oval and square method or the oval round method will assist in eliminating corner checking. The oval and square method changes the corners, therefore the loss of temperature is retarded. The loss of temperature is the main cause of checking on some of the weak or less ductile grades at rolling temperature.

Working in open squares, or diamond and square, the corners are not changed and a greater loss of temperature is bound to occur.

Spreading of stainless grades when rolling bar sections, varies considerably in relation to the grade of stainless, shape of groove and type of section finished.

When rolling rounds (¾-in. diam for example) of straight carbon steel, and changing to a stainless grade, it is necessary to reduce the stock. This may necessitate changing some passes depending on the clearance between the rolls while rolling the carbon grade.

With an oval for ¾ in. turned to a ratio of 1.4 to 1 when rolling carbon steel, the square entering the oval will be 0.790, using the same oval for stainless would require the square to be reduced to approximately 0.760 depending on the grade of stainless.

It is good practice to have the clearance between the rolls at a minimum when rolling stainless, to assist in obtaining as much coverage of the section as possible. This practice will assist in eliminating surface defects.

A. Cameron: I would like to ask a question about Stainless 430, have you experienced excess spreading at higher temperatures or in the early passes, then proceeding along with moderate spread, then excessive spreading reoccurring when the temperature drops to the lower range?

We have found that when rolling small flats of Stainless 430 with as much as 50 per cent draft, we only had 15 per cent elongation.

E. M. D. Herold: Unfortunately during the time I was collecting samples for this paper, we did not roll any 430 grade steel although we have rolled this grade on the 24-in. mill mentioned in the paper. We experienced no difficulty with it although it does spread a lot. We have not noticed excessive spreading in the early and last passes and moderate spreading in the intermediate passes. Our observations have been that it spread greatly in all passes, however, test data may show the same results on our mill as you experienced in your plant.

L. C. Sowell: Since the author's company is essentially a producer of alloy steels, while we primarily make plain carbon steels, and also since the author dealt with a three stand reversing mill, while all of our rolling is on straight away continuous mills, we would hardly be expected to speak the same language. Nevertheless, I find that we have encountered similar problems.

When we started to roll junior channels from a structural grade, ASTM-A-7, of approximately 0.20 carbon and 0.25/0.50 manganese, we experienced considerable difficulty with the steel tearing and the holding of section. However, by raising the manganese to 0.50/0.70 we overcame these drawbacks and now we have a well sectioned bar with good surface.

I notice that the author stated that silicon over 5.0 per cent became non-rollable. I would like to point out that United Alloy at Canton, Ohio used to make an 8 per cent silicon electric furnace steel as a replacement for stainless or duralloy back in the twenties.

It is noticed that in his discussion of the effects of the various elements, Mr. Herold did not mention copper. It has been our experience that steels containing over 0.30 per cent copper produce a very good surface. I am speaking of plain carbon steels with over 0.30 per cent copper without the benefit of any nickel to precipitate the copper.

Our rollers seem to feel that grades containing around 1.5 per cent manganese and 0.10/0.20 per cent molybdenum such as our jalloy No. 3 steel have a different resistance to flow or filling out the passes from plain carbon structural grades when rolled on the same rolls. I would like to ask Mr. Herold what his experience has been and if he concurs in this whether he feels that this is due to the 1.5 per cent manganese or the 0.10/0.20 moly?

I would also like to ask Mr. Herold if steels containing molybdenum have a tendency to produce a heavier scale than plain carbon steels, and if this has proved to be bothersome in obtaining good bar surface.

Mr. Herold quite properly raises the question: "Do delaying elements impart their properties to steel at rolling temperature?" I wonder if the use of hot torsion tests on these various grades where a ⅝ in. bar is twisted to failure at temperatures ranging from 1800 to 2300 F and the number of twists required to cause failure are used as a criterion of the steels ductility and rollability, would shed some light on this question. I understand that the Timken people have done some work along this line.

E. M. D. Herold: Mr. Sowell's statement that a better section was obtained with less tearing of the steel on junior channels when they changed the manganese content from 25/50 to 50/70 may be explained by referring to the properties of the alloy manganese. One of it's properties is that it makes steel more pliable or malleable. This may be the reason for better results when the manganese content was increased.

I cannot comment on your statement concerning copper. We roll copper bearing steels but I have not checked nor noticed particularly that we get any better surface on these steels than on any others with of course the exception of nickel grades.

Your question concerning jalloy No. 3 where you roll steel containing 1.5 per cent manganese and 0.10/0.20 molybdenum I believe may be explained similarly to the junior channel section. The metallurgists tell us that molbydenum makes steel more pliable. I think that it is probably the manganese that gave you the better results.

Concerning the hot torsion tests at Timken, I can only say that I have heard of such tests in general conversation. Not being familiar with them I cannot speak authoritatively, but I have a tendency to question comparing torsion tests with rolling. The actions are entirely different and I question whether one could shed much light on the other.

ELECTRONICS IN THE STEEL INDUSTRY

. . . Past, Present and Future

By H. W. POOLE
Steel Mill Division
General Electric Co.
Schenectady, N. Y.

. . . . electronics should preferably be used in the steel plant only if it will do the job better or at less expense than the more conventional equipment . . . .

▲ BECAUSE we see so many wonderful things accomplished every day by electronic devices and equipments, we are sometimes prone to consider electronics as the panacea for all difficult problems—particularly if we do not fully understand these problems. Some years ago, when electronic devices first were used for industrial applications, there was quite a rush to solve all problems in the steel plant by the use of electronics. Unfortunately, many poorly designed equipments were used and many misapplications were made; and as a result, electronics received a bad name in the industry. Operating and maintenance people began to be very skeptical of any industrial device that contained an electronic tube.

Subsequently, the use of electronic equipment in steel mills dropped to a very low point and it became evident that we must "learn to walk before we could run." Designers had to learn that "radio receiver" type of construction was not satisfactory for industrial equipment which had to control expensive machinery and for processes which cost the user thousands of dollars when shut down for only a few minutes. Application engineers began to realize that electronic applications should be made with due regard for accessibility, ambient conditions, vibration, and a host of other limitations. Users came to appreciate that the type of maintenance equipment and the type of maintenance personnel must be different from that required for contactors, commutators and relay coils.

We have traveled a long way in this latter phase, and we are now reaping the benefits from sound applications of well designed equipment which has been properly installed and maintained. In trying to do our share, our company has the following creed in applying electronic equipment in the steel industry.

Use electronic equipment only if:

1. The job cannot be done in any other manner, or
2. The job can be done better with electronics, or
3. The job can be done satisfactorily but more economically.

To some of you, this may seem like a negative attitude, but it has helped us to avoid a lot of pitfalls. Furthermore, it still leaves much room for plenty of proper applications.

It is not necessary to dwell on the fundamental principles of electronic tubes, etc., but this paper will discuss present applications and practices in this country and abroad and, in doing so, will try to give my ideas of some future trends.

In the steel industry, electronics have been employed in four major fields. They are: (1) power electronics used primarily for power conversion; (2) electronic control; (3) high-frequency electronic heating; and (4) electronic measurements. It is not possible to cover all of these fields in detail, but I will give examples of each and will spend most of the time on power electronics since I believe that this field will be of particularly far reaching importance to the steel industry.

ELECTRONIC MEASUREMENTS

This particular phase of electronic application presents several instances where the job could not be successfully accomplished by other means. One of these is the x-ray gage for hot strip mills where it was physically impossible to obtain a continuous record of the strip thickness until the advent of the x-ray gage. This has been a very successful application both from the standpoint of the user and of the manufacturer.

Under this same topic of measurements, there is another development which promises to be just as significant as the x-ray gage, the new width gage for hot strip mills. This new development has been tested under actual operating conditions in the mill and it was demonstrated at the AISE Iron and Steel Exposition, in Cleveland in 1950.

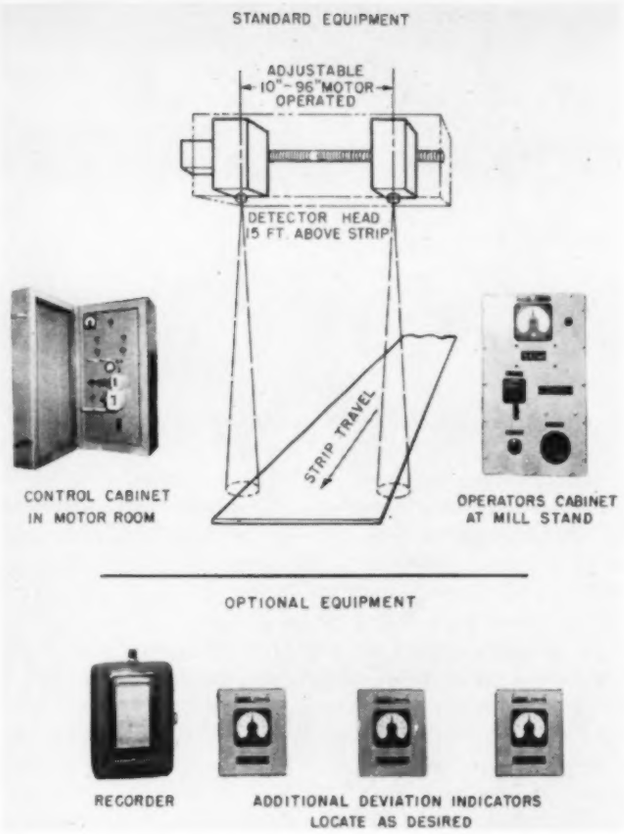
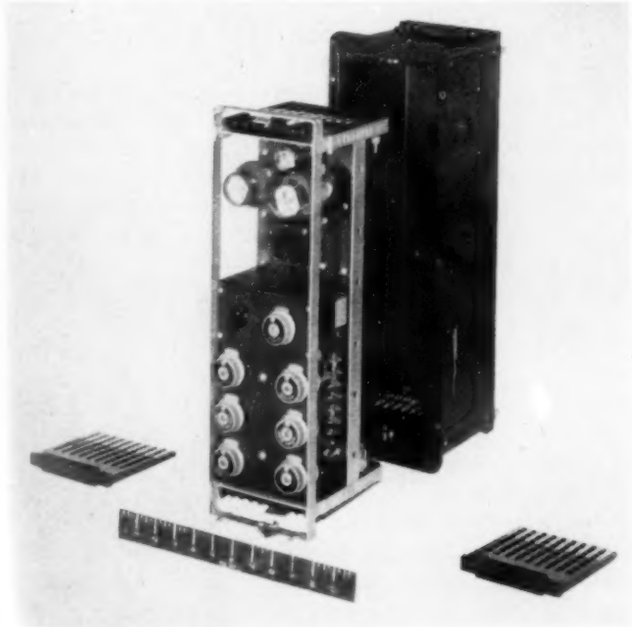


Figure 1 — Schematic diagram of width gage for continuous hot strip mills.

There has been some delay in getting the first production equipment into service, but it is expected that the first one will be shipped soon.

Figure 1 gives a bird's-eye view of the apparatus required to give a continuous indication of the width of the hot metal. The three basic components are the detector head, the control box and the operator's cabinet.

Figure 2 — Drawout type electronic amplifier shows contact plugs, and electronic unit.



The detector head is a long metal box containing two phototube scanning units mounted on a motor-driven screw mechanism with a glass covered slot in the bottom, through which the light from the hot metal falls on the phototubes. The entire unit is mounted about 15 ft above the strip.

The control box contains most of the electrical components of the equipment. It is located in a clean, remote spot—preferably the motor room—for service and inspection.

The operator's cabinet contains a mechanical counter, a deviation indicator, and the necessary switches and controls for setting the basic width and making occasional calibration checks. This cabinet is mounted in a location convenient for mill operation. The counter indicates the distance between the two scanning units as set remotely by the motor-driven screw mechanism. The deviation indicator is calibrated in fractions of an inch to show the actual deviation of the strip width from the desired value as shown on the counter.

THEORY OF OPERATION OF WIDTH GAGE

The detector head, installed vertically above the strip, houses two detectors. These two units are mounted on a precision lead screw and are set at a distance apart equal to the desired width of the strip to be rolled. Thus, these detectors are set over each edge of the strip. Each unit has one edge of the hot strip imaged on it by a lens. The necessary illumination is furnished by the strip itself. The optical image is converted into an electric charge pattern by a phototube. A rotating slotted disc provides the means for repeatedly sweeping across the image of the edge of the strip at right angles to the direction of strip travel.

The resulting light signals cause each detector to produce a pulsating square wave direct current. The length of each pulse is proportional to the distance from the inner end of the sweep to the edge of the steel. The square waves of each detector are amplified and added together, and compared with a direct current to produce a current proportional to the width deviation.

Sidewise motion of the strip has little effect on the accuracy. As the strip shifts on the table, the length of the pulse from one detector becomes longer while the pulse length from the other becomes shorter by an equal amount. The sum of the signals remains the same. Vertical motion of the strip has little effect because the detectors are mounted vertically above each strip edge.

In practice, the operator sets the two detectors the desired distance apart by remote control. The actual spacing in inches and fractions of an inch is indicated on the mechanical counter, i.e. the width indicator. When strip passes under the detector head, its actual deviation from the width set by the operator is indicated in fractions of an inch by the deviation indicator.

ELECTRONIC HIGH-FREQUENCY HEATING

The most outstanding example of electronic high-frequency heating in the steel industry is the tinplate

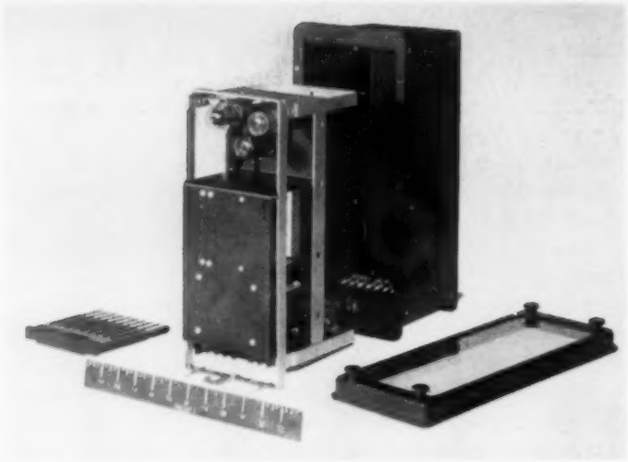


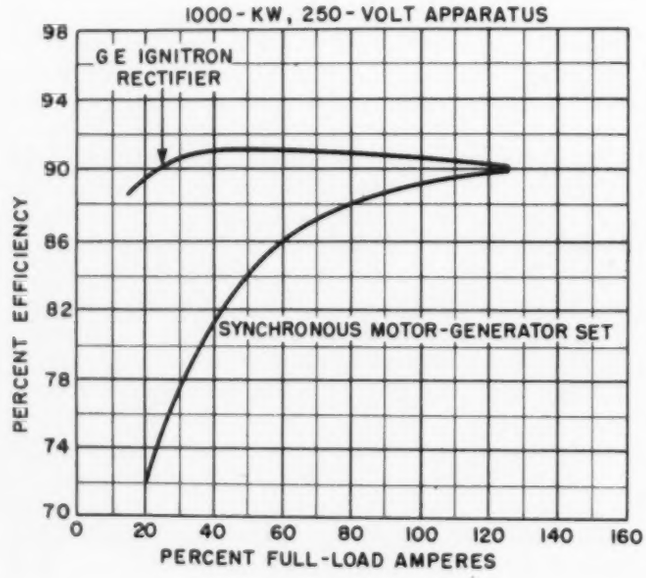
Figure 3 — This electronic power supply is of the drawout type.

reflow process. During World War II when tin became very scarce and the installation of electrolytic lines became necessary throughout the industry, many new problems were introduced. One of these problems was the necessity of momentarily melting the tin coating to give a bright appearance with low porosity, high corrosion resistance, and a good bond between tin and steel.

Four methods of reflowing were ultimately used. These were: (1) the so-called conduction method of passing electrical current through the strip; (2) the gas furnace; (3) the 9600-cycle method employing induction alternators; and (4) the electronic high-frequency method. This electronic method employs transformers, rectifiers, oscillators, and other components common in the ordinary radio broadcast transmitter, and furnishes power at approximately 200,000 cycles per second. Over 100,000 kw of electronic generators have been supplied for this purpose.

In operation, the available 60-cycle, a-c power is converted to a-c at the higher frequency. This high-frequency power is fed into inductor coils which surround, but do not touch, the moving strip. The inductor coils induce current flow in the steel strip—thereby heating the strip to the desired temperature.

Figure 4 — Curves show efficiency of rectifier apparatus.



Inasmuch as one or more of the other methods of tin reflow have proved satisfactory on a large share of the existing tinning lines, it is not correct to say that electronics must or should be used for these applications, but there is no doubt that the attractiveness of electronic heating increases as speeds go up. The original lines were installed for 500 fpm whereas new lines are being installed for 2500 fpm.

ELECTRONIC CONTROL

The term "electronic control" is quite broad since most all electronic applications, whether in the field of heating, measurements, or power, actually involve some form of electronic control. However, there are innumerable applications where electronics are used to detect a signal of some sort and in turn to control some other type of apparatus in response to this signal. Electronic regulators are a common example wherein the electronic equipment detects an "error" signal and adjusts some other component, such as the field of d-c generator, to eliminate the error signal. Electronic regulators are very sensitive and very fast.

Too often, even in these days, electronic control equipments are applied in the steel industry where they do not meet the test of being essential. A good example is the use of electronic speed regulators on some continuous mills where a perfectly satisfactory job can be done without electronics by giving more attention to the design of the driving motors and in extreme cases by the added use of rotating regulators.

In those cases where electronic controls are essential, proper attention must be given to the cost of a shutdown if failure occurs and to the speed with which the failure can be located and repaired. This is not to imply that failures occur only in electronic equipment, but we would be foolish to ignore the fact that the equipment is less able to stand the rigors of steel mill use than conventional contactors, relays, motors, etc. It, therefore, behooves us to design our equipment and our circuits with this fact in mind.

If the process to be controlled is extremely important, we may want to utilize only so-called "hard" or vacuum tubes and not rely on gas-filled tubes. The latter are known to have less dependable operating characteristics than the vacuum tubes. In order to do this, it may be necessary to use a vacuum tube regulator in conjunction with a rotating regulator or other amplifying devices.

This can be done in two ways, either by using the electronic unit as a preamplifier ahead of the rotating regulator or by using the electronic unit as a vernier or ultra-sensitive regulator in addition to the rotating regulating circuit. The former method effectively uses the electronic unit and rotating regulator "in series" with each one entirely dependent on the other and with the output of the electronic amplifier fed into the control field of the rotating regulator. If one unit fails, the whole system is out of service. The second method employs two complete regulating circuits. The two units

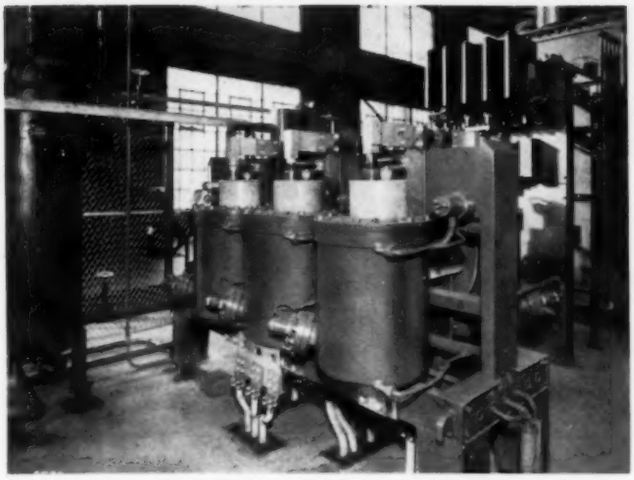


Figure 5 — This pumped ignitron mercury arc rectifier is rated 1000-kw, 250-v.

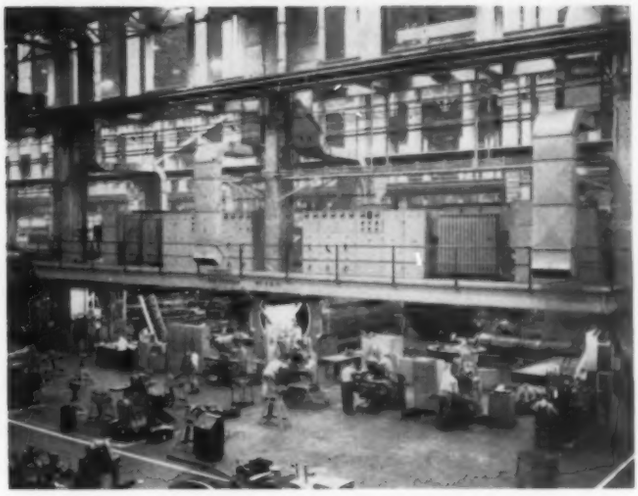


Figure 7 — D-c unit sub-station rated 1000-kw, 250-v, mounted on balcony in large industrial plant.

are effectively "in parallel" since the rotating regulator circuit is a complete regulating circuit and will function within its own limits of accuracy even if the electronic unit is out of service. In this case, the electronic system is also a complete regulating circuit in itself and increases the sensitivity and accuracy of the entire equipment when it is in service.

The foregoing illustrates one method of decreasing the possibility of a shutdown. However, if a shutdown occurs because of electronic failure, we can also do certain things to reduce the time required to put the equipment back into operation. Figure 2 shows an electronic power pack, and Figure 3 illustrates an electronic amplifier both of the "drawout type." The two units were used as a part of a "parallel" system as described above in conjunction with a rotating regulating system. Both units are built into standard drawout type cases used for switchgear relays, etc. With this method of construction, spare units can be substituted in a matter of minutes and a thorough and unhurried job of servicing can be performed on the defective unit. This may be an expensive solution to the problem but, in certain cases, may represent inexpensive insurance against loss of quality production. Obviously, not all electronic equipments are available in this construction, but the trend is in this direction and more and more electronic designs are being "unitized" and made quickly removable.

Figure 6 — Used in a foundry, this sealed ignitron mercury arc rectifier is rated 300-kw, 250-v.

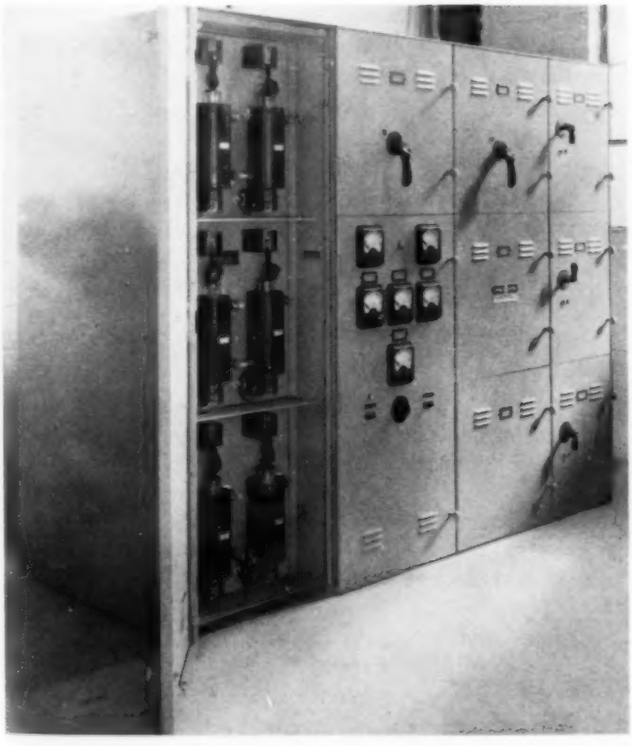


Figure 8 — Enclosed pumpless mercury arc rectifier is rated 1000-kw, 250-v.

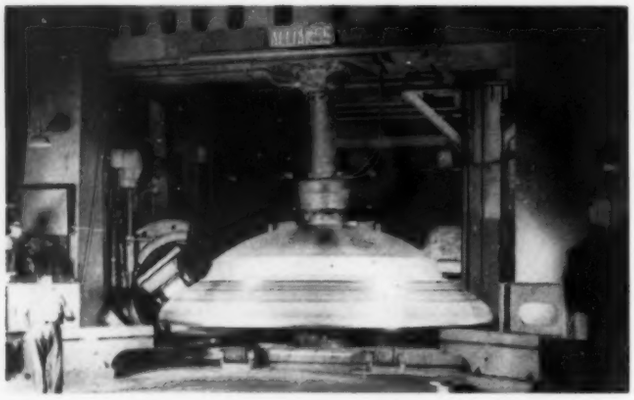
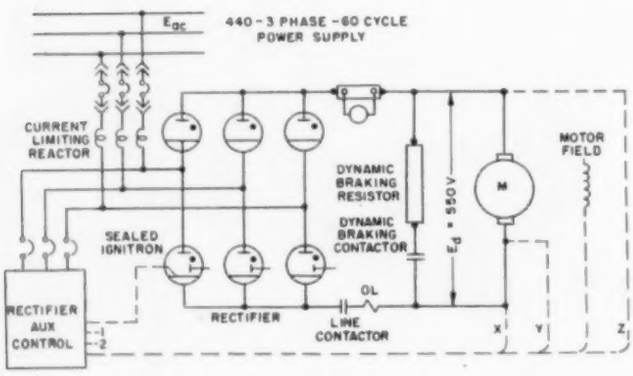


Figure 9 — This 300-in. hot flanging mill is powered by 350-hp electronic motor drive.

Figure 10 — Electronic drive for flanging mill with sealed tube rectifier, primary switch-gear and air cooled transformer are shown installed in basement.

Figure 11 — Schematic diagram of electronic motor drive equipment.



ELECTRONIC POWER EQUIPMENT

Electronic rectifiers are quite common for converting a-c power to d-c power for 250-v constant potential systems. More and more d-c drives are being used in steel plants so that this becomes of increasing importance. The first mercury-arc rectifiers for this purpose were installed about twelve years ago in this country, and up to the present time over 100,000 kw has been installed.

Mercury-arc rectifiers for 250-v d-c supply have a number of advantages over the synchronous motor-generator set:

1. A rectifier is a static device, quiet in operation and well suited for an unattended station.
2. Installation is quicker and installation costs are lower since foundations are not required.
3. Maintenance costs are lower because of absence of bearings, commutators, and brushes.
4. Rectifiers do not increase the short circuit capacity of the a-c systems as synchronous motors do.
5. The rectifier efficiency is higher, particularly at light loads. (See Figure 4.) An annual power savings of 250,000 kwhr per year may result from the operation of a 1000-kw, 250-volt unit for 7000 hours per year.

The power rectifier has one potential disadvantage which should be recognized. It inherently operates at lagging power factor, possibly 90 to 95 per cent on most 250-v constant potential applications and slightly lower on some of the adjustable voltage applications. The power factor drops in the lagging direction in proportion to the amount of phase control used. For this reason, if any appreciable operation at heavy load and low voltage is to be encountered, transformer primary taps should be considered.

The lagging power factor is not always a disadvantage in large industrial plants, such as steel mills, since there are normally a large number of synchronous motors on the system and their leading reactive kva is in the direction to balance out the lagging reactive kva of the rectifiers. On the other hand, it is quite in order to consider the use of static capacitors on the system where sufficient synchronous capacity is not available.

Figure 5 shows a 1000-kw, 250-v rectifier being used for a blast furnace load. Figure 6 is a 300-kw sealed-tube unit in a steel foundry. The advantages of using the load center idea are evident from Figure 7, which shows two 500-kw units located on a balcony in a large machine shop. This idea has much merit for steel mill installations.

Until recently, the larger rectifiers in the 1000-kw and 1500-kw class were built with open construction and required a vacuum pumping system. Recent developments have made possible "pumpless" rectifier tanks in these larger sizes. The tanks are evacuated and sealed by the manufacturer. In case of failure, a spare tank can be installed and the defective unit reconditioned on the site or returned to the manufacturer. Figure 8 illustrates a 1500-kw, 250-v unit. One 1000-kw unit of this type has been operating for over two years in a steel mill in the east with outstanding success, and several others have been purchased.

Mercury-arc rectifiers are also being used for adjust-

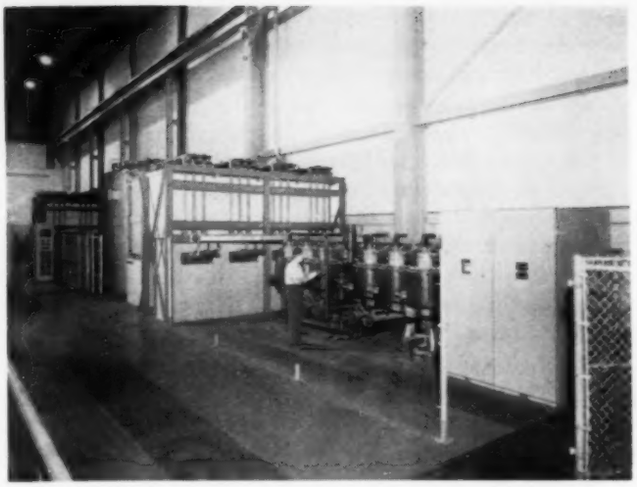


Figure 12 — One of two 5000-kw, 600-v mercury arc rectifiers which supply power to finishing trains of 86-in. hot strip mill.

able speed motor drives such as the large flanging mill shown in Figure 9. This drive consists of a 350-hp, type MD motor with complete speed control by voltage from rest up to base speed. The transformer and rectifier installation is shown in Figure 10.

The distinguishing feature of this type of drive is the fact that normally an anode transformer is not required. It is possible to operate a 550-v, d-c motor direct from a 440-v, 3-phase power supply as shown in Figure 11.

An even larger field for rectifier application exists in connection with main drives for rolling mills. The increasing importance of d-c power for main roll drives is evidenced by the fact that in 1950, 85 per cent of the drives sold were d-c, whereas in 1935 only 74 per cent were d-c.

Rectifiers were first applied to main roll drives about twelve years ago when two 3500-kw, 600-v units were purchased by the Weirton Steel Co. to operate in parallel with three existing 3000-kw synchronous motor-generator sets on its 66-in. hot strip mill. Table I is a tabulation of main roll drive applications made in this country from 1939 to 1951.

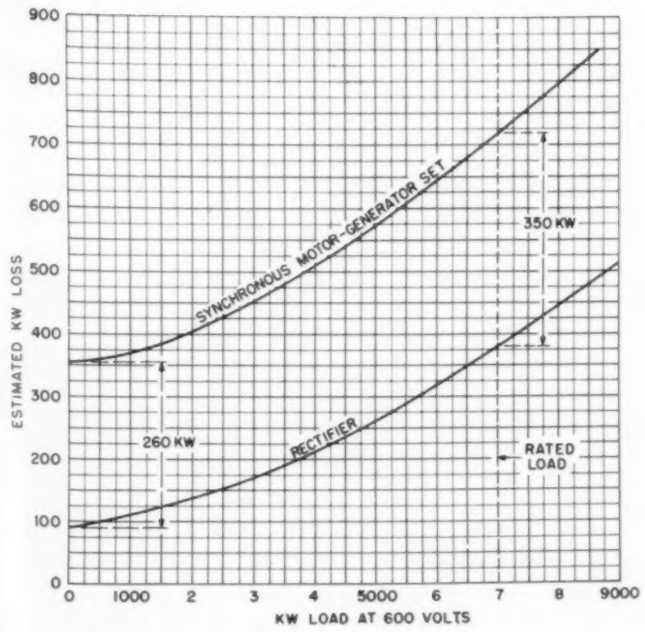
TABLE I

Rectifiers Purchased for Operation of Main Roll Drives in U.S.A.

No.	Year purchased	Year installed	Unit rating, kw	Total kw	Mill	User	Location
1	1939	1945	*2-3500	7,000	66-in. Hot strip	Weirton	Weirton, W. Va.
2	....	1942	*1-3000	3,000	10-in. Hot strip	.....	.....
3	1942	1943	1-2500	2,500	Merchant	Kaiser	Fontana, Calif.
4	1946	1949	1-1500	1,500	Tube mill	National Tube	Gary, Ind.
5	1946	1949	1-3500	3,500	Tube mill	National Tube	Gary, Ind.
6	1948	1949	2-5000	10,000	86-in. Hot strip	Kaiser	Fontana, Calif.
7	1949	1950	*1-4000	4,000	76-in. Hot strip	Bethlehem	Lackawanna, N. Y.
8	1950	1951	2-5000	10,000	54-in. Hot strip	Detroit	Portsmouth, Ohio
9	1950	....	6-4000	24,000	80-in. Hot strip	U. S. Steel	Morrisville, Pa.
10	1951	....	2-3000	6,000	Skelp mill	National Tube	Morrisville, Pa.
11	1951	....	1-1200	1,200	Tube mill	Ohio Seamless	Shelby, Ohio

*These units operate in parallel with existing M-G sets.

Figure 13 — Curve shows that losses of 600-v mercury arc rectifiers are much less than for synchronous motor-generator sets.



The Weirton Steel Co.'s purchase was followed by the use of a 3000-kw unit in parallel with existing generators on a 10-in. hot strip mill and a 2500-kw, 600-volt unit as the sole source of power for a merchant mill at the Kaiser Steel Co. In 1946, the National Tube Co. purchased a 3500-kw unit and a 1500-kw unit for the operation of two continuous tube mills at Gary, Ind. In 1949, the Kaiser Steel Co. installed two 5000-kw rectifiers to power a new 86-in. hot strip mill (Figure 12)—this was the first installation in this country where rectifiers only were used for a hot strip finishing train and provision has been made for the addition of an additional 5000-kw unit when an additional finishing stand is purchased.

Subsequently, rectifiers have been chosen by the Bethlehem Steel Co., the Detroit Steel Co., and the U. S. Steel Co. for hot strip mill drives, and by the National Tube Co. and the Ohio Seamless Tube Co. for skelp and tube mill drives. The installation by the U. S. Steel Co. is particularly interesting since it will represent the largest single rectifier rolling mill installation in this country and because the power supply for the six finishing stand motors will come from three separate

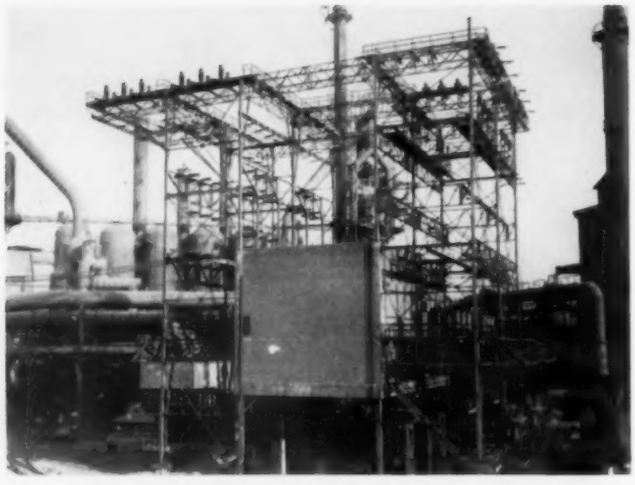


Figure 14 — Two 10,000-kw electronic frequency converters are connected between 25-cycle, 44-kv and 60-cycle, 69 kv-systems.

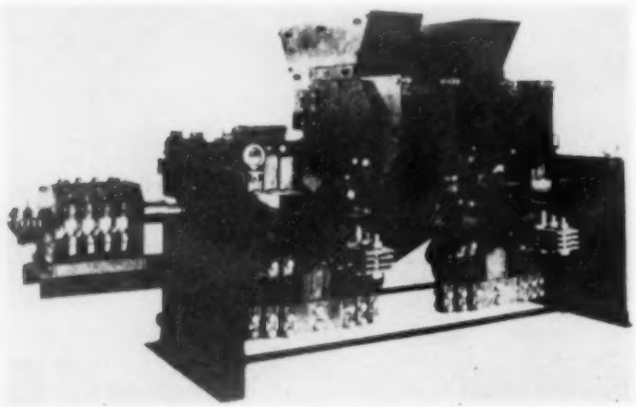
bus sections with two 4000-kw rectifiers supplying each section.

In addition to the advantages mentioned previously for 250-v rectifiers, the 600-v or 750-v rectifiers for main roll drives have additional advantages:

1. Such drives are now installed with amplistat voltage and load control regulators which require no electronic tubes or rotating parts; whereas, generator excitations are so high as to require rotating exciters and regulators.
2. Since rectifiers have much less "electrical inertia" than d-c generators, the voltage control is more accurate for sudden load swings.
3. Because of the higher voltage, the first cost in dollars per kw is more favorable.
4. At the higher voltages, the rectifier losses are much less than those of the motor-generator set (see Figure 13). Three such 7000-kw, 600-v rectifiers operating on a hot strip bus for 7000 hours per year would give an average power saving of approximately 6,000,000 kwhr, or approximately $42,000 per year at 0.7 cents per kwhr.

Another example of electronics at work in the power conversion field is the electronic frequency changer. Many steel mills still generate power at 25 cycles and also purchase power at 60 cycles. It is often advantageous to be able to tie together these two sources of power in order to take mill load from one or the other or both. This is accomplished by means of a frequency changer.

Figure 15 — This reversing contactor for a blooming mill motor of about 7000-hp capacity is used in conjunction with a power rectifier.



Frequency changers may be of the synchronous-synchronous type, the scherbius type, or the electronic type. The synchronous type consists of a 25-cycle synchronous machine and a 60-cycle synchronous machine on the same shaft. It is the least expensive, but the frequency must be quite steady at each end. The scherbius type consists of a synchronous machine coupled to an induction machine with a regulating exciter. This type is more expensive, but it is possible to control the direction and magnitude of power flow regardless of frequency variations.

The electronic frequency changer consists of two power rectifiers—one connected through its transformer to the 25-cycle system and the other through its transformer to the 60-cycle system. The d-c ends of the two rectifiers are tied together and the magnitude and direction of power flow can be adjusted by phase control. Figure 14 illustrates two 10,000-kw frequency changers of this type which tie together a 69,000-volt, 60-cycle system and a 44,000-volt, 25-cycle system.

The electronic frequency changers now installed have proved successful, but their initial cost is relatively high. In general, they have the same advantages as other power rectifiers, but because they draw lagging kva from both power sources, they require that synchronous machines be operating on both systems.

Electronic frequency changers are not the answer to all such problems, but they are entirely practical.

EUROPEAN PRACTICES AND FUTURE TRENDS

In gazing into the probable future, it is always possible to be entirely wrong, but we do have some guide posts such as our own developments and also past and current practices in Europe. It is true that many of our present-day practices stem from European ideas which we developed and improved for our own uses.

For example, the self-saturated magnetic amplifier, which we call the amplistat, has replaced many electronic controls in European practice. This is a static magnetic amplifier with no electronic tubes and no rotating parts. Considerable development work was done in Europe during the war and since then we have been applying the amplistats where we previously used electronic circuits. Formerly, we used an electronic circuit for phase shift control of our power rectifiers, but now we use the amplistat. It is reasonable to expect that this trend will continue since we are currently applying amplistats in other areas where electronic amplifiers would have been called for.

You will note that no mention has been made of the application of rectifiers to cold strip mills. Although rectifiers lend themselves admirably well to continuous hot mills which operate at one voltage for long periods of time, they are not so well suited to reversing applications involving large amounts of power or to non-reversing applications where very large motors must be started and stopped frequently and in synchronism.

Both of these applications require that large amounts of power, from the stored energy of the rotating ma-

chines, be dispatched when slowing down the drives, and fortunately motor-generator sets can readily pump the energy back into the power system with relatively little loss. Since rectifiers are one-way valves, the problem is more difficult. Obviously, it is unsatisfactory to use dynamic braking resistors from the standpoint of power loss and the inability to control the decelerating rate.

In Europe, rectifiers are being applied to reversing cold strip mills and reversing blooming and slabbing mills. Insofar as I know, they are not being applied to accelerating tandem cold strip mills. Originally two groups of rectifiers were used on the reversing mills so that one group could be used to accelerate the mill and the other to receive power during the decelerating cycle. This was obviously uneconomical from our viewpoint and a practice which we have never cared to duplicate. At the present time, they are using one rectifier with a large reversing switch (Figure 15). The control is arranged to reverse the armature circuit of the main motor as the applied voltage and current go through zero on a reversing cycle so that the motor can pump back through the rectifier into the a-c system and then accelerate in the opposite direction.

To date, most of these developments have failed to provide mill performance which equals that obtained in this country with more conventional means; however, we cannot afford to close our eyes to what is going on. With the present state of the electronic art, we do not propose to offer power rectifiers for reversing and/or accelerating main roll drives, but who can say what future developments may bring.

For the present at least, let us be sure that the electronic system will do the job better or just as well at less cost before we apply it.

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Plan to Attend

1952 ANNUAL AISE CONVENTION

AND

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2 AND 3

STAINLESS STEEL

. . . exacting standards and accurate procedures are required to produce stainless products which will satisfy customer demand . . . .

▲ THE term "flat rolled" means sheet, plate and strip. Let us define each of these forms on the basis of accepted North American standards. Sheet is generally recognized as being 24 in. and over in width and under 3/16 in. in thickness. Sheet, of course, can be sheared narrower than 24 in. and therefore, pass as "strips," but if it were made 24 in. or over it is still referred to as sheet. In terms of gage, stainless steel sheets are rolled to the U. S. Standard gage—16 gage is 0.0625 in., 10 gage is 0.140 in., etc., and according to our definition 8 gage is the maximum nominal gage. It is somewhat confusing to find carbon steel sheets rolled to a Revised U. S. Standard which is slightly lighter, but stainless sheets are still rolled to the old U. S. Standard.

Plates are defined as 3/16 in. thick and heavier in any width 10 in. and over and in any length. Thicknesses are generally indicated by figures, 1/4 in., 3/8 in., etc. and not by gage. Widths, 10 in. or less, are bars.

Strip is defined as narrower than 24 in. wide and less than 3/16 in. thick and can be either coils or straight lengths. Since a different gage standard has been followed by the strip mills, it is now standard practice to specify thickness in decimals: 0.050 in., etc. Wider coils, more than 24 in. which are actually within the classification of sheet, are now being rolled, but they are of little commercial interest except to non-integrated mills for re-rolling purposes, because wide strip requires elaborate and very special equipment to handle it, and further, individual sheets, flattened and cut to size, sell at the same price.

Standards of finish, particularly cold rolled finishes are not as clearly defined as these size standards. The reason is that there are some differences between the methods used to produce the so-called standard finishes, not only in the various grades and gages of stainless steel, but in the same grade and gage as produced by different mills to meet specific requirements. It must be emphasized that these variations are primarily confined to the cold rolled finishes and have only become noticeable during the past three to four years when new processing equipment and operations come into use.

Two finish designations, not cold rolled in which there is a fair degree of standardization, are perhaps the oldest and most well established. They are: hot rolled, annealed and pickled—referred to as Number 1; and the Standard Polish—termed Number 4. A step by step review of mill processing will explain this.

THE HOT MILLS

The hot sheet rolling mills are driven by a 1200-hp electric motor through 1500-hp reduction gears at a speed of 29.7 rpm. This driving speed gives a delivery rate of 248 fpm from the 32-in. diam rolls and 225 fpm from the 29-in. rolls.

Figure 1 — In foreground can be seen sheet bar prior to rolling. Jump type, 29 x 56-in. roughing mill is first unit shown in foreground and two mills in back are 29 x 60-in. jump type finishing mills. A 32 x 60-in. balanced mill is the second unit from the front.

PRODUCT STANDARDS

By GEORGE N. MALCOLM
Superintendent
Stainless Steel Mill
Atlas Steels, Ltd.
Welland, Ontario, Canada

The balanced mill gets its name from the fact that the top roll is supported in such a manner that it is always held up against the screwdown chocks at desired height. The maximum roll opening is four in. The top roll is set with the aid of hydraulic plungers for varying thicknesses and is pinion driven by the main drive. The bottom roller is revolved by the drive shaft which operates the entire mill.

The jump mill gets its name from the fact that the top roll rides on the bottom roll and jumps up to make contact with the screwdown chocks when a sheet is entered between the rolls. These rolls are preheated to between 650 and 750 F.

Hot rolling—Depending upon the grade, initial rolling temperatures of 2200 to 2300 F are used and seldom are the "touchy" grades hot-worked less than 1700 F. Compared to carbon steels, very light reductions are necessary, less than ten per cent per pass through the rolls. Several grades, such as Types 309 and 310 are most always forged before they can be rolled.

Better results are obtained by repeated reheatings and re-rollings, often interrupted by partial or even complete surface conditioning by grinding or chipping. Even at this preliminary stage of processing, still far removed from the finish product, surface quality is the essence. A 21-in. ingot rolled down gently in easy stages to a slab, say 12 × 15 in., will yield a far more consistently high quality finished product if it is allowed to cool and is surface conditioned prior to further rolling.

As mentioned, the selection of ingot size depends upon the type of rolling mill and the end product desired. Plates in large patterns are made on large reversing mills from ingots approximately 17 × 42 in. in cross section and weighing up to seven or eight tons. The operation is confined to flattening, spreading and lengthening the material through short and fat intermediate slab sizes down to finished thicknesses, widths and lengths.

In contrast to the hot rolling, a relatively recent method of producing sheets is the orthodox method of rolling which involves an intermediate product known as a "sheet bar" which in a simple sense is nothing more than a strip slab cut into short lengths, for example 2 × 15 × 39 in. long. This sheet bar, completely conditioned by grinding, is charged into furnaces heated to rolling temperatures and "cross-rolled" to the finished hot rolled sheet in single stand mills, often through intermediate or breakdown stages. Cross-rolling means the length of the sheet bar roughly becomes the width of the untrimmed sheet (for example, 39 in.) the longest dimension entering the rolls. The combination of thickness (2 in.) and width (15 in.) determines the length obtained for a given thickness or gage of the finished sheet.

As the material becomes progressively thinner, it becomes increasingly more difficult to retain sufficient heat for individual sheet rolling on the hand mill. It is common practice, therefore, when rolling lighter than 14 gage to double the sheets or pack one on top of the other for rolling together. To reduce the lighter than 20 gage requires a stack of four thicknesses. The extra handling and repeated heatings actually make it more economical to cold roll gages 18 and under.

The demand in Canada is still too limited to justify continuous mill equipment. Even with high production in the States, continuous mills operate almost exclusively on only two or three of the thirty old grades in demand. All the other grades, being ordered in small lots, are still produced on hand mills as individual sheets.

ANNEALING AND PICKLING

No matter what the form—sheet, strip or plate—hot rolling is followed by annealing or softening. Various temperatures (1400-1600 F) and cooling rates are required for various grades. Descaling of sheet and strip is accomplished in a series of hot acid baths and plate is often sand blasted. Thorough surface cleaning is necessary for Number 1 finish surfaces of good corrosion resistance, and for efficiency in further processing.

Number 1 finish, reached at this point of processing is generally open grained and might best be described as frost-white. Since the final pickling solution, a combination of nitric and hydrofluoric acids, has removed all scale and contaminating foreign metals, the surface now possesses the inherent passivity of stainless steels. For most industrial corrosive conditions, this hot-rolled, annealed and pickled product is ample.

COLD ROLLING

Since highly polished stainless steel is in great demand for dairy and food equipment, for consumer products and for purely ornamental applications, further work by cold rolling is desirable to smooth out this open grain surface to make it easier to polish. The uniform lustre and smoothness of a cold rolled stainless steel surface and its polishability is directly related to the amount of cold reduction it is given.

Polishability, or degree of surface smoothness, is not alone dependent upon the amount of cold reduction, but also upon the character of the last and possibly the next-to-the-last annealing and pickling cycle. It should be clear that if high temperatures and strong pickling

Figure 2 — Partially rolled stainless steel sheet is shown entering the jump mill.

solutions are used, the surface of the material is apt to be rough due to oxidation and the action of the acid in removing tenacious oxides. On the other hand, if the annealing temperature is on the low side of the range (care must be taken not to go too low or harmful carbides will not dissolve) strong pickling action is unnecessary and the surface remains smooth. Controlled atmosphere annealing has the same effect.

It is the delicate balance between starting surface and operations, amount of reduction, care in rolling, temperature and atmosphere in annealing, pickling cycle and the final "skin pass" through highly polished or dull rolls (without reduction) which determines the exact character of cold rolled stainless steel. The various grades react differently to the same mill practice. Thus it is now readily understood why it is difficult, if not impossible to strike a single common standard which completely describes 2B or 2D sheet finishes or No. 1 or No. 2 strip finishes. Cold rolled sheets are given a minimum of 15 per cent cold reduction. Gages less than 18 receive more reduction since, as has been pointed out, it is easier to reduce light gages cold than hot in spite of frequent intermittent reannealings. Plates are seldom cold reduced since slight cold reductions improve the thicker material very little.

Figure 3 — After shearing, hot rolled, annealed stainless sheets are pickled to remove mill scale formed during rolling.

POLISHING

No matter what finish the mill starts with to produce polished stainless steel sheets, the end product described as Number 4 standard is the same. The only variable is the amount of work necessary to obtain this standard, easily recognized by experienced producers and fabricators.

Start with a Number 1 surface and it is necessary to rough grind with 50 to 60 grit abrasive to get down under the open grained surface, perhaps 0.003-0.004 in. Start with a cold rolled surface and the mill must still rough grind, perhaps with less metal to remove, to arrive at the homogeneous base surface which is the real starting point in the polishing cycle necessary to to achieve the sparkling Number 4. From this common base, successively finer grit abrasives are applied until about 150 to 180 grit with wax produces the final surface effect.

If Number 4 standard finish was not actually a consistent standard, it would be impossible for the user to match one batch of sheets with another. For example, if a fabricator was installing panels in a restaurant and it was necessary to call on more than one source to secure the stainless sheets of the size needed, or if he had to obtain two different lots from the same supplier, any difference in lustre or polish would stand out like a sore thumb.

Other polished finishes have been tried but with waning popularity. Number 7, an "almost mirror" finish, not quite free from all fine abrasive scratches but possessing a very high lustre, is popular for press plates used in moulding plastic table top material. Number 8 is the full mirror finish but is seldom used. Even Number 6, which is a soft satin Tampico brushed finish is no longer specified because it is not consistently obtainable, and the brighter Number 4 seems universally preferred as a more pleasing general purpose standard.

Polished sheets are always stretcher or patent levelled whereas other finishes are supplied roller levelled unless table top flatness is specifically required.

Pressure sensitive adhesive paper is used to protect polished surfaces during fabrication. To avoid die marks and work scratching, the paper is applied either at the mill or on arrival at the fabricators plant. After the product is completed the paper is easily pulled off.

Polished sheets are always boxed and usually about 750 lb placed in each box. Other finishes are likewise safest when boxed or, when it is possible to handle 2000-lb lifts, completely encased skids are permissible.

Air Cleaning for Motor Rooms

By T. O. ZITTEL
Assistant Superintendent
Electrical Department
Bethlehem Steel Co.
Lackawanna, N. Y.

. . . . in order to get good filter operation it is necessary that the unit should be properly engineered . . . . the cleaning features of the filter may be more important than the efficiency . . . .

▲ MANY not familiar with the requirements of electrical equipment probably do not realize that one of the greatest problems facing an electrical engineer is that of providing proper ventilation where his equipment must operate.

Admittedly some electrical apparatus does of necessity operate under very adverse conditions, but this is generally specialized equipment designed for operation under such conditions. However, it is sometimes necessary to use ordinary equipment under adverse conditions where it may fail often and where maintenance cost is high.

Compared with designs of 30 or 40 years ago, modern motors and generators are far more powerful in relation to their size. Through this increase of capacity, it has been possible to build the present day close-coupled and powerful rolling mills. The permissible increase in capacity, while partly due to improved insulation materials, has been attained mostly by improvements in internal ventilation. The modern rolling-mill drive, whether self-ventilated or force-ventilated, has many small air passages through which air flows at high velocity. Large amounts of internal heat can be thrown off without damage to the windings if the machine is provided with the proper amount of clean, cool air.

Besides the above factor, several other reasons make clean air essential in the operation of electrical equipment. Many kinds of dust in steel plant areas are conductors of electricity. Since they accumulate in machines they often produce shorts or grounds which result in flash-overs and other failures, particularly in d-c equipment. Abrasive dusts, which are also often present, along with other dusts, cause poor commutation, rapid commutator or collector-ring wear, and require frequent maintenance.

In order to maintain equipment ratings, reduce failures, lessen maintenance costs and costly shutdown, and lengthen life of electrical equipment, it has therefore been found economical for steel plants to ventilate electrical equipment adequately, especially motor rooms, where large quantities of this equipment are concentrated.

Motor room ventilation has the following functions to perform:

1. Control air temperature.
2. Clean the air.
3. Circulate the air.
4. Provide make-up air.

It is common practice to clean all the air when a non-recirculating system of ventilation is used, and only the make-up air when a recirculating type of ventilation system is used.

This paper deals with the portion of the ventilation system designed to clean the air, particularly the filter. Figure 1 is a schematic diagram of its location in a ventilation system.

There are three general types of filters: the traveling-screen, self-cleaning oil-film filter, the electrostatic type, and the air washer. On some small installations "throw-away" type replacement filters or small manually cleaned filters are used.

The choice of a filter is often a difficult one. Each installation must be studied to determine which is the best type for the conditions involved. There is no perfect air filter, and in spite of the claims made by many manufacturers of this equipment, there is yet to be

Figure 1 — Schematic shows filter location in air installation.

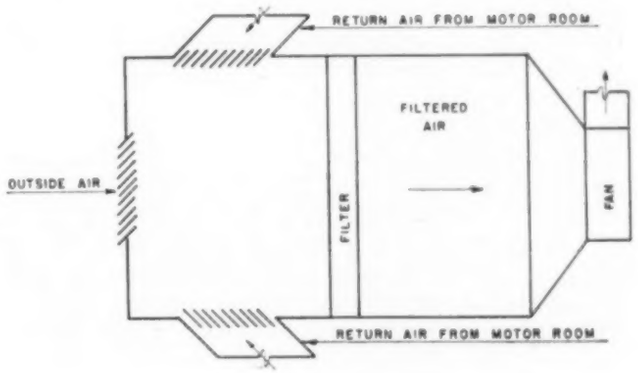


Figure 2 — Delivery side of traveling-screen, self-cleaning, oil-film filter.

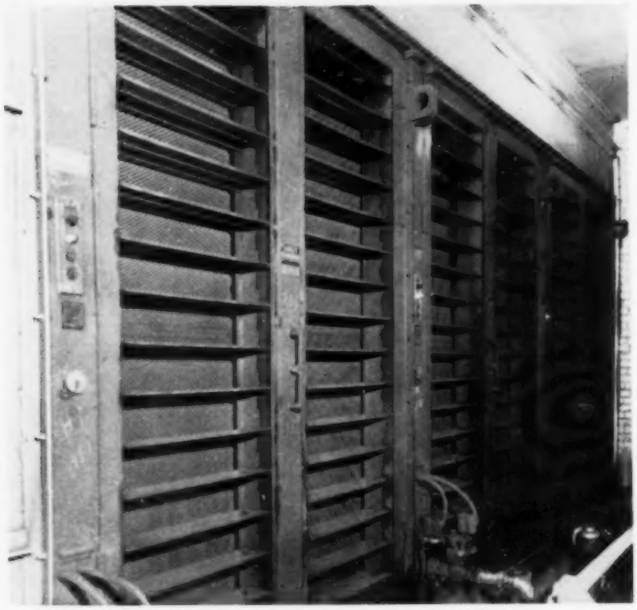


Figure 3 — Entry side of 48,000-cfm electrostatic filter.

found a filter that can be considered entirely satisfactory for all installations, or for that matter, for any installation.

Because steel mill atmospheres normally contain a certain amount of dirt, it is now common practice to specify a filter 25 per cent larger than would be recommended by manufacturer's ratings. This practice provides an added safe-guard against dirt or adhesive carry-over.

Figure 2 shows the delivery side of the traveling-screen, self-cleaning oil-film filter used in the hot strip mill motor room. It has a rating of 25,000 cfm. Modern designs of this type have been improved to some extent, but still employ the same principle of operation. The filter consists of overlapping panels suspended from cross rods, and supported on each side by endless chains which travel over sprockets. The curtain is rotated by means of a ratchet mechanism which moves it about three-quarters of an inch every twelve minutes. As the filter panels accumulate dirt, they are gradually brought around to the oil pan at the bottom, cleaned, and put back into service. Air flows first through the cleaner panels and then through the dirtier ones. Efficiency in removing fine dust increases somewhat with slightly dirty panels. Principal maintenance requirements are that sediment be cleaned from the oil pan periodically, and that oil be changed occasionally. When using this type of filter, it is necessary to have a low air velocity to prevent oil carry-over.

Figure 3 shows the entry side and Figure 4 the delivery side of the type of electrostatic filter recently put in operation in the cold mill at the Lackawanna plant of Bethlehem Steel Co. It is unit-designed for 48,000 cfm, consists of 3 cubicles, is semi-automatic in operation, and any one unit can be cleaned while the others are in use. In order to put the cleaning or washing cycle in operation, it is only necessary to close the louvers, cut off the power of one unit and set the wash cycle into operation by pushing a button. After the wash cycle is completed, the adhesive is again sprayed on the plates automatically and the unit is ready to be put back into service manually.

Most engineers are familiar with the principle behind the operation of an electrostatic filter, as illustrated in Figures 5 and 6. The air must first pass through a fly screen to eliminate insects and large particles that would cause shorts on the ionizing wire. It is then passed through baffles to distribute it uniformly through an ionizer to charge airborne particles, and through a number of collector cells to catch the charged particles. There is also an afterfilter to capture any agglomerated particles which may blow off or otherwise become dislodged from the collector cells during operation. While this type filter is excellent for fine dust and smoke, it becomes rapidly overloaded with very dirty air. In many cases it should be preceded by another filter, to take out the bulk of the dirt, or the installation should be designed to deposit the heavy dirt before it enters the filter.

The third major type of filter used for large motor room areas is the air washer. In the Lackawanna plant, most of the installations up to about 1936 were of this type. These older installations consist of a perforated baffle plate at the entrance of the washer, to distribute the air, and a spray chamber that is entirely filled with a finely divided water spray from equally spaced spray nozzles. This spray wets the dust or dirt particles, which are carried on through to a set of eliminator plates. The first section of these plates is kept covered with a sheet of water by additional spray nozzles. The dirt is thus deposited on the eliminator plates, washed off, and carried away to the drain.

The modern version of this air washer, now installed at our 10-in. bar mill, is essentially the same in operation except that the spray chamber also contains a spun-glass filter over which water is sprayed and through which the air flows.

Figure 7 shows schematically this modern unit. In

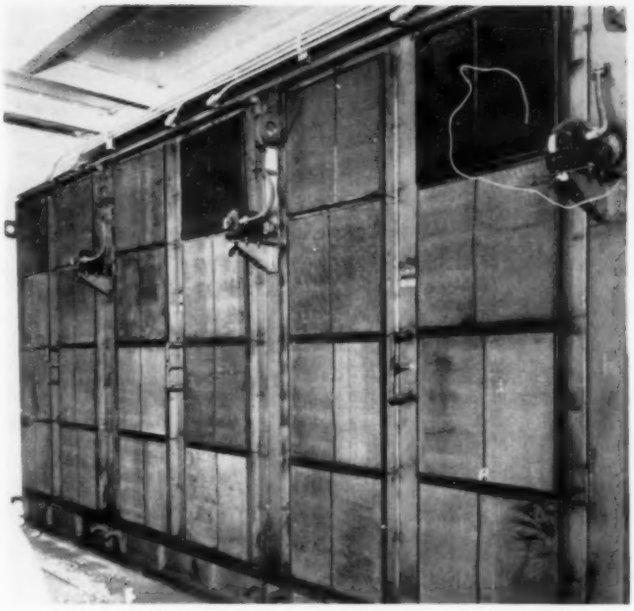


Figure 4 — Delivery side of 48,000-cfm electrostatic filter.

some installations water is re-used and pumped around the system. The water level is maintained by a float system and new water is added as required. Because of the removal of chemical fumes, it is necessary to maintain a constant discharge from the sump tank to prevent acid concentration from building up. Best results are obtained, however, when all fresh water is used. With an arrangement of non-recirculation, the water will constantly overflow from the collecting tank below and carry off dirt or weak acids from the oxides washed from the air. This insures air-washing equipment that is constantly self-cleaning, and results in longer life and less maintenance.

Care must be taken, when the air-washer type of filter is used, that the intake air to the filter is kept above 32 F, preferably about 45 F. In most installations this can be done automatically by louvers electrically controlled by a thermostat in the intake air stream, so that a sufficient amount of warm air from the motor room is recirculated, and the mixed air is kept at any pre-determined temperature.

This type of filter gives the added advantage of evaporative summer cooling and winter humidification, which recent studies have appraised as an important factor in brush life.

An interesting comparison (see Table I) of these three types of filters has been made by S. L. Jameson in his paper on "Ventilation of Steel Mill Electrical Equipment" as published in Blast Furnace and Steel Plant, July, 1950. This table fits in well with this discussion and with our ideas and experience.

One who is familiar with motor rooms and the rapid accumulation of dust in windings, in spite of the filters, can hardly leave this problem without some comment on this condition. Unfortunately carbon dust from brushes is an existing evil which adds to other accumulated dust. In our maintenance programs, we periodically blow out machines to clean the air passages, and to remove accumulated dirt. The dust in most cases is not collected but goes out into the room and lodges in other machines. There is, therefore, a great need for a good system to accumulate this dust and take it out of the room.

The ultimate in filter design is probably a combination of the units discussed, with some method of recirculating the air through a filter to catch the carbon dust and other dust that accumulates in the motor room itself. To date, to my knowledge, no such installation has been made, probably because of the high initial cost.

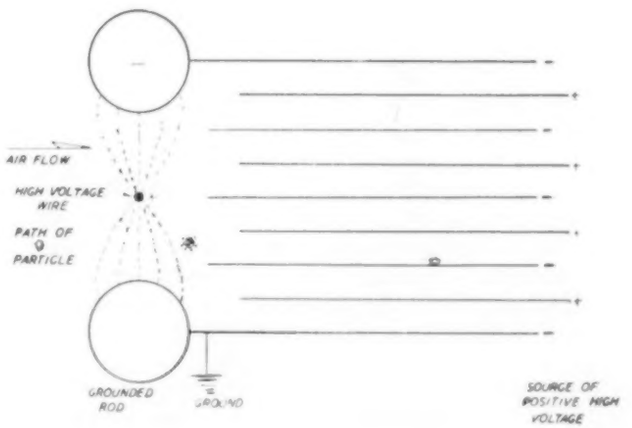
Several other factors should be considered in designing the air-cleaning equipment for a motor room. The location of the fresh-air intake is most important, since

TABLE I

Filter Type Comparison

Dirt removal	Oil film	Electrostatic	Air washer
Ordinary dirt	1	3	2
Very fine dust	2	1	3
Smoke	3	1	2
Chemical fumes (SO_2, Cl)	No effect		Some
Winter operation	Ok		Entering air must be above 32 F
Humidification and evaporative cooling	Auxiliary sprays required		Inherent in operation
Sludge disposal	Manual or clearing system may be added		Flush to sewer
Fire danger	Minimized with fire resistant adhesive and built in sprinkler		None
Floor space and weight	About equal		Most
Cost	Least	Most	

Figure 5 — Sketch shows principle of operation for electrostatic filter.



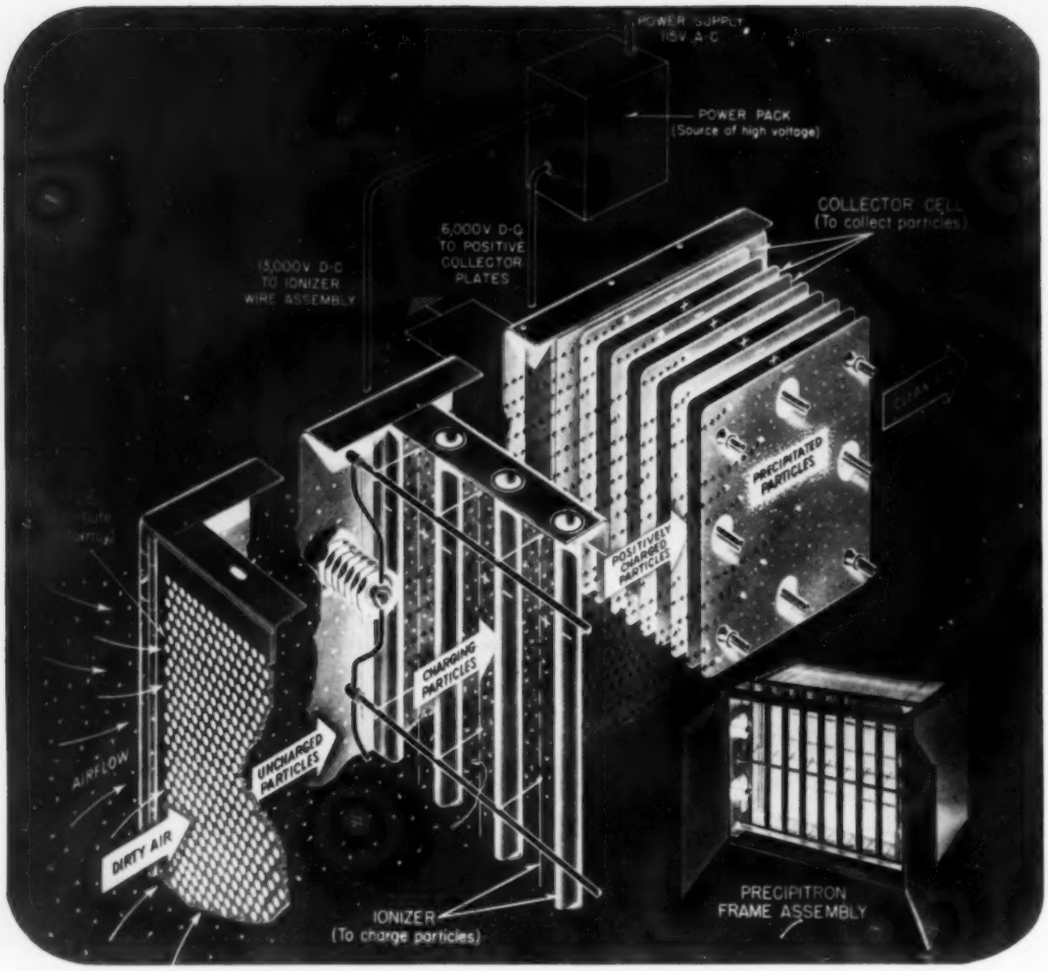


Figure 6 — Various components of electrostatic filter units are shown in this picture.

with a little care, the work a filter has to perform can be greatly reduced. The prevailing winds, and location of dust, fume or gas sources should be taken into consideration to determine intake height and physical location.

Another factor that should not be neglected is the existence in many motor rooms of gear units and similar devices which discharge oil vapors. Dry dust can be readily removed by blowing or vacuuming but oil vapors mixed with dust make dirt removal a difficult task, especially when large equipment is involved. Therefore, it becomes necessary to see that all such oil vapors are piped from the room, and oil leaks kept to a minimum.

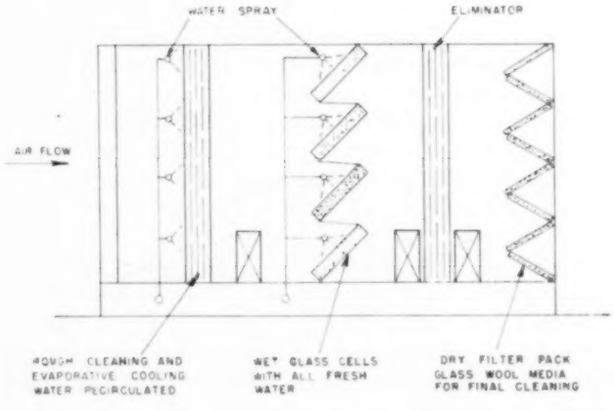
Then there is the necessity of keeping dust and dirt from seeping into the room from the outside. This makes it important to have as tight a room as possible. In some of our newer motor rooms, all windows have been eliminated and replaced by glass block. By making a tight motor room, and by bringing in a sufficient quantity of make-up air, so that a positive pressure is maintained in the room, all leakage is kept at a minimum. Care should be taken to see that the make-up air is introduced at the proper point to keep a large portion of the system from having a negative pressure, and to see that the portion that is at a negative pressure is as tight as possible. Intake air ducts particularly must be tight to avoid entrance of undesirable gases, fumes or dust.

The final factor to be considered is the presence of gases or chemical fumes in the area of the equipment or of the intake duct. When these are present, consideration must be given to their removal when the choice of filter is made. As mentioned before, the air-washer type of filter will remove certain chemical or gas fumes, and its choice alone may solve the problem if concentrations are light. Also a water curtain ahead of one of the other filters might give satisfactory results. With heavier concentrations, it may be necessary to resort to activated charcoal or other chemical filters to do a good job.

To sum up this important problem of air cleaning of motor rooms, attention must be given to many items:

1. Type of filter for the dirt concentration.

Figure 7 — Schematic shows operation of air-washer type filter.



2. Location and design of intake air duct.
3. Introduction of a sufficiently large amount of make-up air into the system at the proper point, to maintain a positive pressure.
4. Elimination of oil vapors from the room.
5. Design of as tight a room as practical.
6. Elimination of any gases or chemical fumes from the outside air.

If all these factors are carefully considered, the result will be one entirely satisfactory for the equipment involved, and one that will minimize maintenance, both of the filter and the electrical equipment in the room.

DISCUSSION

PRESENTED BY

C. B. HUSTON, Commercial Engineer, General Electric Co., Schenectady, N. Y.

PHILIP B. MANSFIELD, Electrical Engineer, Engineering Department, Republic Steel Corp., Buffalo 20, N. Y.

C. B. Huston: We do not make filters and are unbiased in this respect. Nevertheless, in building steel mill equipment and in designing motor rooms, we must become familiar with various types of filters, their characteristics and their adaptability to the particular local conditions. Consequently we are frequently called upon to make recommendations for the type of filter best suited for the particular installation.

We have been given figures on the efficiency of filters which we by no means dispute, but regardless of how efficient the filter may be, it has no greater value to the ultimate user than its convenience for getting rid of the dirt. We have found many installations which have started out brand new and clean, but when coming back in a few months—not a few years—but just a few months, we find that because of the kind of housekeeping which the operating people have been carrying on, the room, the machines, and all equipments are dirty. We have been called upon, in some cases, to investigate why insulation resistance deteriorates. We examine the dust particles which are scraped off the windings of the machines. We test the sample in the laboratory, and find forty or fifty per cent is iron dust. We may have been called in to begin with because of the complaint that carbon dust from the brushes was piling up in the machines. So far we have not found any brush manufacturer using iron dust in the manufacture of their brushes. The deductions are that the iron dust is coming in through the ventilating system and along with it a great deal of carbon dust.

Regardless of the intent of the operating plant in trying to do a good job of maintenance, we believe that a great deal of responsibility lies with the manufacture of the filters. I personally have been preaching for many years for improvements, not in the efficiency of the filter itself, but improvements in some means of getting rid of the dirt after it has been collected. In some cases it becomes necessary to actually shovel it out. It is a job requiring boots, gloves, coveralls, and all, and consequently when this job is to be done, that is the operator's day off. These conditions I am not exaggerating, and I think Mr. Zittel will fully agree.

The filter designs have improved a great deal over the past few years, but yet there is much to be done to make it convenient to get rid of the dirt. There is still good reason for having the different types on the market. The local conditions are not always the same. Therefore, in properly designing the motor rooms we have need for different types of filters. Notwithstanding, the means of getting rid of the dirt has been one of the factors in choosing a design of filters. This dirt handling problem has also led to a great extent for the choice of a re-circulating system using surface air coolers.

It becomes no small problem to get rid of the heat. In some stations, the amount of heat may be as much as 1000-2000 or even 3000 kw in loss. Therefore, a choice must be made when selecting a ventilating system of either filtering a very large amount of air, if the air is to be used only once, or to recirculate after cooling and then provide a smaller amount of outside air for makeup. In the former case the design of the filters and the method of disposing of the dirt plays the greater part in influencing the choice of type of filter.

It is very gratifying to have a paper such as that presented by Mr. Zittel. It is especially fine that it comes from an operating man. It shows that the electrical departments of the operating companies are finally prevailing upon their managements that ventilating systems with filters, coolers, fans and any other accessories are a necessary part of the electrical equipment, and that these parts should be purchased and installed with just as much care and attention as is placed in the handling of the main mill drives.

Philip B. Mansfield: I would like to ask Mr. Zittel if in ventilating a motor room he prefers a system in which the washed air is conducted to the machines and then exhausted into the room and returned to the washer, or would he prefer a method in which the washed air is taken into the room, then drawn through the machines and returned by duct work into the washer for recirculating?

T. O. Zittel: We have both, but just which one is the best is hard to say. Most of our recent installations have been of the re-circulation type, where make-up air is brought into motor room and all the air is drawn through the machines, through a cooler, and discharged into the room again. The motor room is kept at a positive pressure with the make-up air.

Philip B. Mansfield: What I was concerned with, was the choice between the two methods. Do you have any comparison between the efficiencies of the two systems?

C. B. Huston: We have an installation which exactly answers the descriptions which you mentioned. It is at Geneva Steel in Provo, Utah. The equipments were ordered during the early stages of World War II. One started out to be a plate mill at the Bethlehem Steel Co., Sparrows Point, Md., and then later was transferred by the Government to the mountain regions far from the seashore. The other part of the equipment was ordered later through the Carnegie-Illinois Steel

people, who were the acting engineers on the project of building the plant.

Both motor rooms have a recirculating system with surface air coolers. One station provides for the return of the air to the machines piped directly to them. The air which is recirculated does not communicate with the air in the room. The other station has the air returned to the room which is used as a plenum chamber. The air is then picked up by the machines, discharged downward, cooled and returned to the room.

Insofar as the merits of the two systems, in cooling the machines, there is no particular difference. You will observe one minor difference when entering the stations and that is the station which has the entirely enclosed recirculating system confined to the machines themselves is a little quieter. Here full-sized covers are used on both ends of the machines which seems to be responsible for reducing the noise to some extent.

Even a few years ago it was criminal to cover up the commutators of any direct current motor or generator. Today it is accepted practice. The commutator is covered up, and the discharge from the machine is carried directly downward, and along with it the carbon dust from the brushes. With this arrangement, the other end of the machine may be left open, thereby making it more convenient for the attendants to blow out the machines. When so doing they may still keep the ventilating fans running, thus maintaining the suction which will carry the dirt which has been loosened down into the basement. If this practice is followed, the carbon dust will be collected in the basement below from where it can be swept up.

If the motors and the generators are to be assembled out in the mill, then complete covers on both ends are required. The recirculating air then is confined to the enclosed channels in the basement. However, where the machines are installed in a motor room and where it is the intention of the operating company to build the motor room as near airtight as possible, there is no reason that the room should not be used as the common return path for the air. In this case one end of the machines may be left uncovered.

There is one point on which I wish to comment further and that is in regard to where the make-up air may be brought into the system. In case of the completely enclosed system, the make-up air should be brought in at the low point of pressure in the recirculating system which is at the suction side of the fans. If this is done, the system as a whole will be raised above atmospheric pressure and will prevent all vapors and dirt being sucked into the machines if the covers are not real tight. In the case of the motor room layout the make-up is usually delivered directly to the motor room chamber. Here it is desirable to keep the room itself slightly above atmospheric pressure and thus eliminate infiltration of dirt from the outside.

PLAN TO ATTEND

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NETHERLAND PLAZA HOTEL CINCINNATI, OHIO

APRIL 28-29, 1952

Discussion of
The Axial Compressor for Blast Furnace Blowing

. . . . this discussion covers the paper by W. O. Lowell of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., which was published in the October 1951, Iron and Steel Engineer . . . .

DISCUSSION

PRESENTED BY

WALTER N. FLANAGAN, Fuel and Furnace Engineer, United States Steel Co., Pittsburgh, Pa.

N. R. KIRKDOFFER, Superintendent, Power and Steam Department, Inland Steel Co., East Chicago, Ind.

SAM H. JONES, District Manager, Askania Regulator Co., Chicago, Ill.

C. G. HOGBERG, Assistant to Chairman, Blast Furnace Committee, United States Steel Co. of Delaware, Pittsburgh, Pa.

DAN L. NEWKIRK, Manager, Blast Furnaces & Coke Ovens, Ford Motor Co., River Rouge Plant, Dearborn, Mich.

BATT L. SPAIN, Manager, Turbo Blower Department, Ingersoll Rand Co., New York, N. Y.

R. N. WILLIAMS, Manager, Blower Department, Elliott Co., Jeannette, Pa.

W. N. Flanagan: The high efficiency of the axial flow compressor has for many years intrigued steel works engineers. In these days of abnormally high construction costs, any constructive measures to hold down operating costs are well worth analysis and the figures given by the author appear attractive. This discussion is an attempt to analyze whether or not the axial flow compressor meets all of the requirements for blast furnace blowers.

A modern blast furnace plant represents an investment of approximately $25,000,000 and consumes over $20,000,000 worth of raw materials per year (in addition to labor, maintenance, blowing utilities, etc.).

The difference in installation cost between one type or another of turbine driven blowers is $50,000 or 0.4 of 1 per cent with a difference in operating cost of perhaps $27,000 or 0.14 of 1 per cent.

The above factors, in addition to the danger from explosions as well as loss of tonnage in case of sudden failure of blowing equipment, have developed the following order of importance in requirements for blast furnace blowers:

1. Reliability.
2. Control with simplicity.
3. Range with simplicity.
4. Freedom from trouble caused by dirt, oil, etc.
5. Thermal economy.
6. Space.

DISCUSSION OF FACTORS

The builders of turbo-blowers have been circumscribed by the users.

1. *Reliability*—Limitations placed on turbo-blowers by requirement No. 1 have caused the following sacrifices in thermal efficiency:

A. The use of stiff shaft turbines and blowers. This is occasioned by the fact that the only turbo-blower or large turbo-gas booster wrecks were flexible shaft units.
Steam economy of the driving unit could be increased by flexible shaft turbines which would permit the use of a greater number of stages with resulting increase in efficiency.
The efficiency of the blower would be increased by opening the eye of the impeller.
These factors are sacrificed to obtain a unit with no critical speeds from zero to above maximum.

B. The use of lower steam pressure and temperatures. This has been resorted to by many plants in the interest of reliability by elimination of unproven materials and by reduction in thermal shocks due to sudden checking of the blast and subsequent rapid return to full load and speed.

C. It is possible to increase the efficiency of the centrifugal blower by impeller design, but this leads to the same type of pressure-volume relation characteristic as the axial flow type (80 per cent instead of 75 per cent adiabatic compression efficiency is possible without too greatly affecting characteristics).

I assume that Mr. Lowell in his reference to higher rpm turbines refers to flexible shaft units. Normal axial flow blowers of blast furnace ranges are inherently rigid shaft units.

2. *Control*—It is highly desirable that the blower can

handle variations in pressure automatically and respond to any reasonable induced change in volume through operation of reliable and simple equipment.

The introduction of additional mechanical devices decreases reliability. Some use has been made of a blow-off valve with centrifugal blowers but this causes loss of efficiency if utilized in more than emergency.

3. *Range*—Blowers must be capable of being applied to any desired furnace in the plant, i.e., a large or a small unit and there have been many business years which required underblowing of certain blast furnaces. Therefore, a low pumping point is desirable since continued operation with a relief valve would be uneconomical.

At this point an analysis of types of pumping point is desirable. The conventional centrifugal blower sooner or later runs into a pumping point which is merely a back and forth change in flow due to the droop of the PV curve in both directions. It is affected by the resonance characteristics of the system to which the blower is connected.

The axial flow blower has a breakdown point which has been described by Salisbury* as follows:

"Eventually, however, increase in the discharge pressure causes an excessively high 'lift' of the airfoil sections and results in a sudden breaking down of their diffusing properties. At this time the compressor is likely to become unstable, and destructive vibratory stresses may be set up."

Likewise at breakdown point and toward zero volume, the quantity and frequency of the noise produced is undesirable.

Many of us have experienced pumping point phenomena of centrifugal blowers both in blast furnace service and in shop tests (with and without check valves). Nothing alarming resulted other than knowledge that continued operation under this condition would damage stove linings.

The axial flow blower if permitted to operate long at the breakdown point would probably not only lose blades but also develop irritating noise. If carried successfully through the breakdown point, the axial flow blades develop partial centrifugal characteristics but at the expense of noise.

4. *Freedom from troubles caused by dirt, oil, etc.*—Axial flow blading appears to be more susceptible to deposits of oil and dirt from intake air. This difficulty has been reported from gas turbine installations. The centrifugal blower and the axial flow are both susceptible to erosion from grit in the intake air, but the axial unit is sensitive to the point of loss of output by nondamaging dirt.

5. *Economy*—As previously discussed, the axial flow blower exceeds the normal efficiency of the centrifugal blower. However, by sacrificing normal range characteristics the centrifugal blower can be built to approach axial flow efficiency. To date, economy has been sacrificed in the interest of users' demand for reliability and range without resource to blow-off valves.

6. *Space*—The axial flow blower of any capacity will be smaller in diameter than a centrifugal unit but will normally be approximately as long. In any event the length usually determines blower room dimensions. With demand for greater capacity it will sooner or later become necessary to accept the axial flow blower characteristics, with accompanying benefits and disadvantages. The diameter of centrifugal blowers will someday exceed shipping limits in width.

*"The Basic Gas Turbine Plant and Some of Its Variants," by J. Kenneth Salisbury, Turbine Engineering Division, General Electric Co. ASME meeting, May 8, 1944.

CONCLUSION

The axial flow blower offers economy at the sacrifice of certain characteristics. The flexible shaft turbine is in the same category. The time is approaching when the axial flow design may be a necessity. Therefore, a careful study of its characteristics and means of reliably utilizing them is desirable. Mr. Lowell is to be commended for presenting a paper that so realistically brings out comparatively characteristics of both axial and centrifugal compressors as well as a suggestion for control.

To utilize the axial flow compressor as a blast furnace blower will necessitate the abandonment of all of the design safeguards the steel industry has to date demanded.

W. O. Lowell: I would like to comment on the points raised by Mr. Flanagan in the same order in which they were made:

My reference to higher speed turbines being inherently more efficient than lower speed units is, to my knowledge, an accurate statement keeping in mind that existing turbine designs will be used as blast furnace blower drivers. The reference to higher speed turbines does not necessarily mean that flexible shaft units are needed to gain this advantage.

The blower control as proposed in this paper does include more equipment than the usual centrifugal blower control. I do not believe, however, that the addition of a blow-off valve will seriously complicate operation because this phase of the control is provided with a manual control switch located on the blower panel board. In the event the valve did not open automatically, the operator can manually position the valve from the panel board, using the air flow meter as a guide.

With regard to the question of operating range it should be understood that the axial compressor does have different characteristics than a centrifugal. Since it is essentially a large volume machine it should not be applied in exactly the same manner as a centrifugal. Each type of machine has its good points as well as bad.

Where a single centrifugal blower is suitable for blowing a large variety of furnaces, the axial is better for a base load machine. Each type has a definite place where it excells, and the axial compressor will require a different line of thinking for proper application from the standard method of selecting a centrifugal blower.

As for the question of pumping, I believe this was overstressed by Mr. Flanagan. The axial compressor will not immediately lose blading if it is allowed to operate in the surging region. Each axial compressor my company tests is checked to determine the pumping limit and this entails putting the machine into pumping. As in the case of centrifugal blowers, however, it is not the best policy to operate a unit for prolonged periods in the surging region. When a unit does begin to surge,

steps are usually taken to bring the unit back to stable operation as quickly as possible. It should be kept in mind that a blow-off valve is included as part of the control of an axial compressor which provides immediate control of volume being handled by the axial unit. As for the extra cost of operating the axial unit with the blow-off valve open, reference should be made to Figure 7 of this paper which shows the steam flow comparison of both an axial and a centrifugal unit showing that the higher efficiency of the axial saves steam flow even though the blow-off valve may be partially open.

The axial compressor blading is not as rugged as centrifugal impellers but it is rugged enough for the service. It must be remembered that the usual point of wear on a centrifugal impeller is at the junction of the impeller blade and the hub disc where the air impinges and is directed up through the impeller. Axial blading is positioned in the same direction as the air coming in to it so a condition of streamline flow exists through the blade path. Experience with axial compressors in the petroleum field has shown that deposits may build up on the inlet edge of blades to a slight degree but there is no serious eroding effect on the blades.

W. N. Flanagan: I did not mean to say it was theoretical. I just wanted to indicate that there is quite a difference in the basic designs. I still believe I am correct on the question that if blowers were to enter the pumping point, it would cause more damage to the axial than to the conventional centrifugal type. What I really want to point out is the fact that steel men are going to have to revise their conceptions of blast furnace blower requirements and release the restrictions imposed on turbo-blowers to date if axial flow blowers and flexible shaft turbines are to be accepted.

W. O. Lowell: There is no question but what the centrifugal blower is a more rugged machine. We have analyzed the blade design from the operating characteristics that we know are going to apply and we feel it is a rugged enough design to take the service.

N. R. Kirkdoffer: We, in the steel industry are vitally interested in keeping our operating and maintenance cost at a minimum. We are also interested in rugged yet flexible, low cost units for our blast furnace blowers. We must have a compressor that will take the abuse that is required when a blast furnace is having trouble, such as a slipping or hanging furnace or the abuse resulting from such human failure as opening or closing the wrong valve. Coupled with this ability to stand abuse, the compressor must be flexible enough to give us good operation at varying load conditions as demanded by the blast furnaces.

The axial unit as described in Mr. Lowell's paper seems superior to the centrifugal compressor in its ability to provide constant high volume service with high overall turbine and compressor efficiency.

We believe that the axial compressor has a definite place in the field of industry due to its ability to deliver large volumes of air at high efficiencies, but we feel that many maintenance and operating problems will require further study before adapting this compressor to blast furnace use. This prompts the following questions:

1. Since the blowing rooms are located near the coke plant and blast furnaces, what would be the expected blade life when handling atmosphere containing flue dust and coal dust?
2. Is it necessary to install a unit to filter the dust and moisture from the intake air?
3. What would be the extent of damage, and, what would be the cost and time required for a blading job in the event of a blade failure?
4. Can units be operated in parallel and do you have any information on same?
5. What clearance can be expected in this unit between the stationary and rotary elements as compared to those of the centrifugal unit?
6. Over a given pressure range at a constant volume, the speed of the axial compressor is changed less than in the case of a centrifugal blower operating over the same pressure range. It is believed that this condition demands a more sensitive control to maintain successful operations. What are your experiences in your control system when operating under conditions of fluctuating pressure and volume?
7. The use of the automatic blow-off valve which is required to make the axial compressor adaptable to wide range operation requires an extensive control system which may tend to increase maintenance and operation difficulties. In addition the problem arises as to the increase in cost due to waste of wind. Have any studies been made as to the cost of this during day to day furnace operation?

W. O. Lowell: I do not believe I can answer the question of expected blade life because that is a relative matter.

The comments that were made for the previous discussion will apply concerning the streamlined flow through the machine and I do not believe that erosion will be a serious problem. However, the inlet air should be filtered as well as possible, because you want to keep the air as clean as possible. I do not believe it is necessary to protect the axial machine more than you would want to protect the centrifugal, because you do have a serious erosion problem on the centrifugal which has to be watched. As far as the expected blade life is concerned, that is relative compared with the amount of dirt that is coming through.

As to the time required for a blading job in the event of a blade failure, blades are such that they can be made up ahead of time and it would take approximately a week to install a new set of blades.

The matter of cost is always difficult to tell. The blades, of course, are a significant part of the cost of the unit, and should a blade failure occur in the inlet of the machine, undoubtedly it would affect the blade rows following it. We have eliminated all points that have given us blading trouble in the last fifteen years of designing axial compressors, so we are not anticipating blade failures.

Concerning the operation of axial compressors in parallel, the axial is better suited for parallel operation than the centrifugal. The steep pressure-volume characteristic of the axial insures that with the same pressure applying at the discharge of both units that are operating parallel, you have one volume and one volume only at which these units can operate.

In the internal clearance of the unit, there is about 0.050 tip clearance on the rotary and stationary blade. In other words, the distance from the end of the blades

to the cylinder is about 0.050 in. The axial clearance between the stationary cylinder blade and the moving spindle blade is about ¼ in.

Concerning the control, I would like to ask Mr. Jones, if he will comment on that point.

S. H. Jones: If you recall the pressure volume curve that Mr. Lowell has shown you, you will remember that in going from about 20 psi discharge pressure, to 25 psi discharge pressure, the change in volume would be on the order of 3000 cfm. Now 3000 cfm is not quite as good as most people would like to have, but it still is not too bad. Therefore the axial flow compressor is far easier to control when it is in the stable range than a comparable centrifugal machine. When it gets into the pumping limit, however, the success of the control system is dependent upon proper operation of the waste valve.

It is to be expected that the axial flow compressor would be designed to match the pressure volume characteristics of the furnace on which it is to be used. Under normal conditions, the waste valve would not be required to operate. The waste valve is then expected to operate only if the furnace slips or hangs.

W. O. Lowell: As to the increase in cost due to the use of the waste valve, I believe Figure 7 showing the equal line of steam flow in the writeup will answer that question.

Carl G. Hogberg: Those of you who are closely associated with operations know that many blast furnace plants suffer from a shortage of available blast volume, especially during the warmer summer months. Under today's conditions of maximum demand for blast furnace products, most blast furnace operators would look forward to the prospect of increased blowing capacity, regardless of its source, as long as that source can be depended upon to deliver the desired quantity without interruption. This latter factor is, of course, one which is of most interest to the engineer under whose responsibility such equipment is operated and maintained.

We are fortunate in having present an operator whose long experience in the field is of particular value in this discussion of an important blast furnace auxiliary:

Dan L. Newkirk: The author stated his case and summed it up when he said that so-called free air costs money. Any steam savings of ten per cent or more should be looked at. It is not my intention to enter into an analysis of performance curves. They are determined in the shop under controlled test conditions and are matters for the experts to argue and disagree over.

What blast furnace operators want is reliability and uniformity. This is obtained by simplicity and ruggedness. We want a machine that will not lie down under difficulties which may result in a slag-filled furnace blocking the blow pipes or a total failure which will fill the stoves and blast mains with gas resulting in disastrous explosions. We want a machine that, when the gas pressure goes from twenty to thirty psi and a check is put on the furnace, the short valve opens and when the stock rod shows movement, the short valve closes and the resulting shock wave of air, when it hits, the machine will take with ease, comfort and incipient impunity. We don't want close clearances. We want a machine with guts. We don't want a Swiss watch. We want a Patton tank.

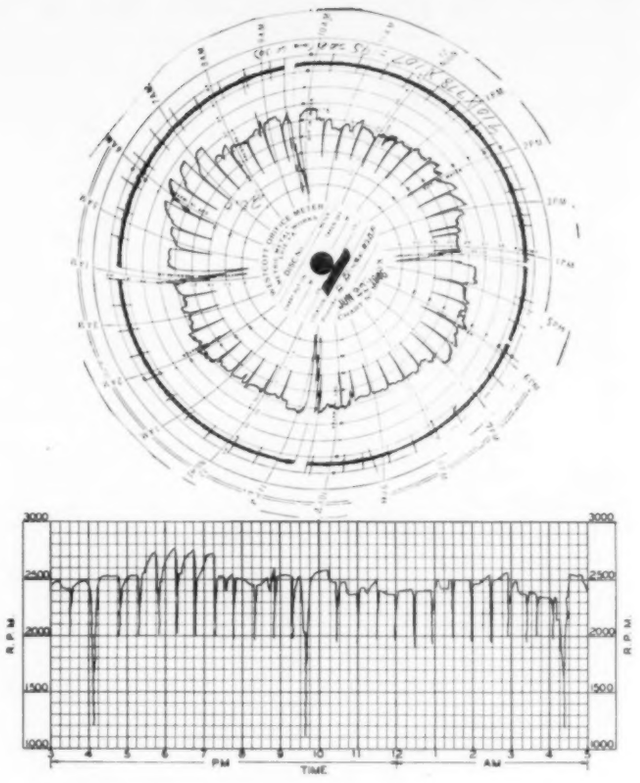


Figure 14 — Operating chart for blower on a Southern blast furnace.

A few of us are still around that well remember the improvement of turbos in the last thirty years; the flexible shaft, stiff shafts, crackpot devices with Rube Goldberg connections to the governors, not to mention the trials and tribulations attributable to bearings and steam valve control devices.

No one who has any conception of the evolution of blowing equipment from the air bellows and water wheels through the reciprocators to the present magnificent machines would say that finality has yet been reached. Maybe some day we will build an oxygen plant next to the furnace and turbos won't be needed.

However, it can be said that of all the present adjuncts to the blast furnace, the present turbo blowers give the least trouble at the lowest maintenance cost.

In plants of the Ford Motor Co. since 1920, three radically different turbos have been installed and they all operate today, but the latest is by far the best. It has operated for three years without interruption. For the past six months it has been blowing 95,000 cu ft of air. This is not a record. It is only a testimony.

Now to get to the meat of the paper. It is my opinion that the metering and volume control in the discharge line will not work the first time, but that does not mean never. It may take months or years. The pumping or surging of centrifugals on low volumes and high pressures has been the bane of the manufacturers and the headache of operators for years, and it has not yet been overcome.

Of great importance is control hook-up. Drafting room designs and shop conditions are far different from job conditions. On the job you are faced with lag and

feed back. Harmonics get to working, vibration ensues and the system goes into oscillation and hunting. Then we get the boys with the screw drivers. They dampen the system and lose sensitivity and response.

Batt L. Spain: Mr. Lowell has presented an excellent paper on the axial compressor—a machine which has interested research and design engineers for many years. Although our activity in regard to this type of blower or compressor has been extensive, we feel it is unsuitable for general use in its present state of development.

The principal advantage of the axial blower seems to be its relatively high efficiency. The author claims a 9.7 per cent saving over the conventional centrifugal type of blower. This improvement, according to the paper, depends upon the successful operation of a system of control which has many functions. In other words, this control is affected by, and it must respond to, such variables as inlet air temperature, barometric pressure, blower discharge temperature, blower discharge pressure, steam pressure, steam temperature, vacuum, and the fluctuating demands of the furnace. The two separate control systems proposed, involving for impulse mechanisms and five operating cylinders represent a combination of control elements which suggests hunting or "bucking" of the system as a whole—and therefore instability of blower performance. Furthermore, since a change must take place before a control system begins to function and since a time element is involved, it would seem the waste valve mechanism should be made to open before the actual surge curve is reached. If this is a logical conclusion, then the comparison of steam requirements of the two types of blower shown on Figure 7 should be modified.

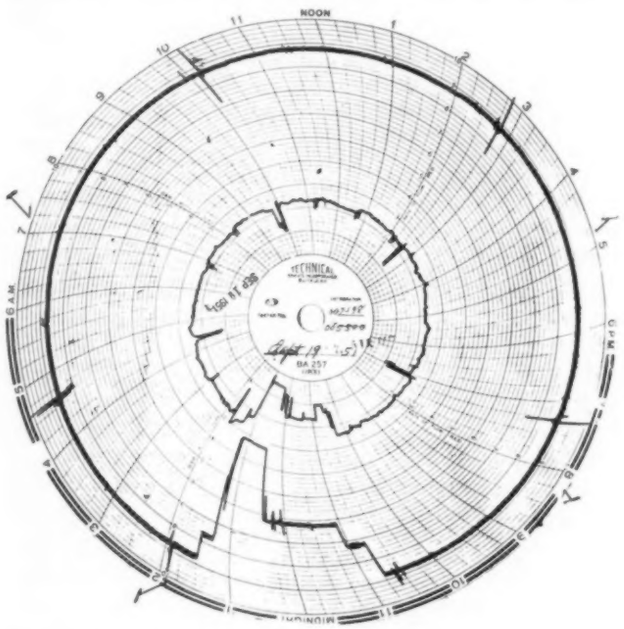


Figure 15 — Pressure and volume curves from Northern furnace given in chart show wide variations.

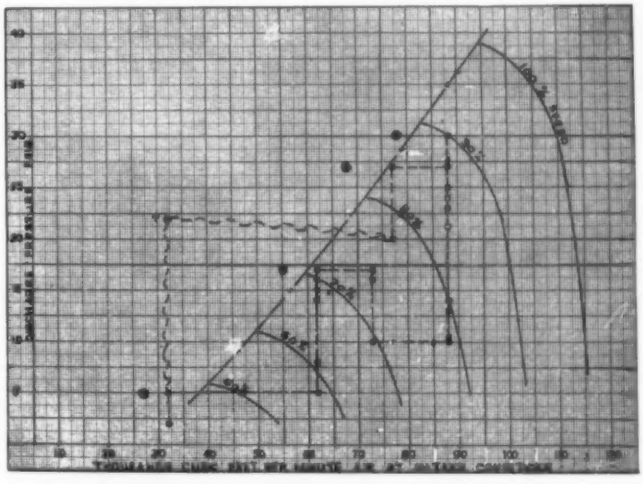
The best way to analyze the range of conditions under which a blast furnace blower must operate is to study the pressure and volume charts of various furnace installations, for instance:

Figure 14 shows the pressure and speed fluctuations of a blower furnishing 95,200 cfm standard air (14.7 psi abs. and 60 F). This operating chart of a southern furnace was taken on June 22, 1946. This chart does not represent average blast furnace practice in the United States, but it does serve to show what may be expected of the type of blast furnace blower now in common use. Just below the pressure-volume chart there is reproduced, in part, the corresponding speed fluctuations, showing the changeable conditions under which the blower is operating. Also, this lower curve shows the manner in which the pressure of the furnace, and therefore the pressure of the blower, is continually changing. This chart emphasizes two facts, namely: the ever-changing pressure requirements of a furnace and corresponding blower speed variation of 25 to 43 per cent.

Figure 15 shows the pressure and volume fluctuations of a northern furnace on September 19, 1951. Again, this is not typical of daily furnace operation, but, when a furnace, for any reason, is operating at other than normal conditions, the blower is expected to deliver air under any of these conditions which may exist. It will be noted that the chart, between 10 p.m. and 2 a.m., shows wide variations in volume and pressure.

Figure 16 shows the recorded volume and pressure of the previous chart, between approximately 10 p.m. and 2 a.m., superimposed on the author's pressure-volume chart (Figure 3). In other words, we begin at approximately 10:45 p.m., with a volume of 87,000 cfm against 24 psi pressure, and attempt to approximately reproduce the chart up to 1:45 a.m., when the volume is again restored to normal and the pressure has settled from the maximum of 30 psi down to about 25 psi. Obviously, the exact volumes and pressures between the minimum idling condition and the restoration of normal operating conditions is somewhat uncertain, and we have, therefore, shown the 32,000 cu ft-24 psi point with a question mark, and connected this point with the rest of the curve by irregular lines. It will be seen that a number of these points are on or below the surge curve. The author has used an average volume of 85,000 cfm, which we assume is measured at 14.7 psia and 60 F. Therefore, we have shown four points on this figure which would represent the corresponding performance

Figure 16 — Data of Figure 15 is shown here superimposed on Figure 3.



on a day when the temperature is zero. These points are shown to be below the surge curve of the unit, although there would be some modification in the location of this surge curve resulting from a reduction in speed under the extreme cold weather condition.

Considering the variable conditions shown on these charts, it would be interesting to know if the proposed control has actually been tried out on a blast furnace blower installation.

In addition to the higher efficiency of the axial blower, the author also credits the use of a more efficient steam turbine as a part of the overall improved economy of the axial blower unit as compared with the conventional radial or centrifugal type, and higher operating speed is given as the reason for better turbine performance. Since low-speed turbines may be designed for high efficiency, it seems likely that the use of a turbine designed for generator drive is referred to in the paper. It may be assumed that for either type of blower, turbines of equal efficiencies may be made available if present reliability requirements are abandoned. Therefore, the 15 per cent overall improvement mentioned in the paper may be reduced to 9.7 per cent and the $20,000 per year saving, referred to, becomes $13,000 per year. Furthermore, the efficiency of centrifugal blowers may be greatly improved by sacrificing reliability; and if the steel industry is prepared to accept turbine driven blowers of less rugged construction and with somewhat narrower stable operating ranges, I believe a large part, if not all, of the difference between the two types of blowers claimed by the author, may be eliminated.

R. N. Williams: Mr. Spain mentioned the possibility that improved overall performance can be realized by sacrificing some of the reliability and flexibility, factors that have always been considered so important in the steel industry. I want to emphasize my complete agreement with this statement and to add a few comments which I believe will be of interest.

In respect to reliability, I believe that most operating personnel feel quite strongly that stiff shaft construction is desirable to minimize the risk of going up and down in speed at frequent intervals. If a flexible shaft turbine is to be considered in connection with the axial compressor, the centrifugal should be given the benefit of similar treatment. A flexible shaft turbine can definitely be built for better efficiency than a comparable stiff shaft turbine would have.

In respect to flexibility, centrifugal blast furnace blowers have frequently been purchased for capacities well beyond the actual anticipated operating point. In many cases, the same blower is available for use on furnaces of several ratings. The blower has consequently been designed to have a considerable range of stability. Our company has built thousands of single stage superchargers for four-cycle diesel engines. Since the point in using a supercharger is to increase the output of the engine with minimum increase in weight of the equipment, efficiency is of prime importance. This application lends itself to the use of a blower with high efficiency and minimum stability, the pressure-volume curve resembling that of an axial compressor. There is, therefore, plenty of background upon which to base the design of a blast furnace blower to give the ultimate in efficiency but with stability comparable to that of an axial machine. This would place the centrifugal on more nearly the same basis as the axial proposed by Mr. Lowell.

In connection with the control, measurement of the capacity on the discharge side presents some real problems. The necessity for measuring air density over quite a range of pressures and temperatures is not easily accomplished.

Summarizing, if we stick with the concept that a stiff shaft machine is necessary for blast furnace blowing, there is no question about the practicability of designing a centrifugal with limited stability and efficiency closely approaching that of a comparable axial. If the axial is considered in conjunction with a stiff shaft turbine, the overall performance becomes even closer and there is little advantage in favor of the axial machine.

I believe that the axial compressor has a definite usefulness, particularly for extremely large capacities. Misapplication of an axial can do a great deal of harm to the blower industry and to the steel industry. There is still a great deal to be done in the development of an axial compressor and we shall unquestionably find applications where it can be used to real advantage.

S. H. Jones: In reply to the comment that the control system is complicated, I believe we all agree that if the job could be done with one regulator, or even none, you would be better off. If you count the number of regulators in the axial flow system, you will find it more complex than in the usual centrifugal blower control system. However, so far as being stable is concerned, it would not be too big a problem to make it stable, because of the pressure volume characteristics.

As far as measuring the volume on the discharge side of the machine is concerned, it is more difficult to compensate for the pressure and temperature changes. However, it has been done for about two years at the Algoma Steel Corp. Operating conditions of course, are slightly different as you may recall from the paper given last year which described the split-wind operation. See paper "Blast Furnace Controlled Split Wind Blowing at Algoma Steel Corp.," by William O. Bishop, Iron and Steel Engineer, July 1951, p 78-83. Adequate results were obtained when controlling the wind to the furnace in the high pressure line in this steel plant.

W. O. Lowell: I would like to make two more points. First is the question of the rating of the axial compressor. It is not the same type of unit as a centrifugal and for that reason I think, care should be taken in establishing the exact rated point of the axial. It should not be made at necessarily the same point as you would rate a centrifugal machine and I believe that the comparison made by Mr. Spain would be aided greatly if the axial were rated at a slightly lower volume. The axial has enough flexibility in the rating that it can be changed as conditions call for it. I think the question of studying the exact rating for the machine is of the utmost importance in applying the axial to a blast furnace.

The other point I would like to make is that the axial compressor is essentially a large-volume machine, and I believe that it is going to come into its own as the volumes keep increasing. It is not intended, and I hope I did not create the impression that it is going to completely supersede the centrifugal, because that is not the case. Each type of unit will have its own place.

Comparative Economics of

THE ELECTRIC FURNACE AND OPEN HEARTH

By H. W. McQUAID
Consultant
Cleveland, Ohio.

. . . . under many conditions, the modern electric arc furnace can compete economically with the modern open hearth . . . . scrap cost is greatest hindrance to electric furnace expansion . . . .

▲ TO produce a clear cut and comprehensive study of the many problems involved in the selection of such an important unit as a steel melting furnace, it is necessary to investigate carefully many contributing factors besides the comparative thermodynamic efficiency or the investment and direct operating costs.

The problem is of one kind with a relatively large steel consumer at some distance from a steel making center who is trying to insure himself an adequate supply of his basic raw material when and as he needs it and at a cost which helps his competitive position in his own market. The problem of melting furnace type is of another kind to an established steel producer with his own excess hot metal and undernourished rolling mills. It is still another type of problem to the relatively small rolling mill operator dependent on a large steel producer (and usually competitor) for his rerolling billet stock. The problem varies with the plant location, the general economic picture, the end product and conversion facilities.

In some cases the decision as to the type and source of melting equipment is determined primarily by the investment, in others by the cost of operation, and in others by what someone with authority thinks the future will bring. There are indeed many factors which must be carefully studied before a final sound decision can be made as to whether the electric arc or the open hearth is the melting furnace best suited for a given operation.

The modern open hearth is, generally speaking, at least for high tonnage production and best operating economy, a relatively large unit with anything under 150 tons capacity being considered "small" and relatively costly to operate. The electric arc furnace is on the other hand a comparatively small unit with 50 to 100-ton furnaces being considered "large" and furnaces as small as ten-ton capacity being used to produce carbon steel ingots for rerolling into product competitive with the open hearth.

In any discussion such as this it is difficult to avoid general statements which always have exceptions and also special cases which are confusing to anyone trying to get a clear picture of the overall problem. Many open hearth furnaces are in operation of less than 100 tons capacity and several of less than 50 tons capacity. These represent usually the older melt shops installed more than twenty-five years ago or shops making special forging ingots or special steels.

At the present time, approximately twenty-five per cent of the open hearth furnaces operating in this country are under 100 tons in rated capacity. Fifty per cent are between 100 and 150 tons in rated capacity, with the balance 150 plus tons rated capacity. The conditions and economics involved in operating open hearth furnaces of less than 100 tons capacity are much different than those involved in operating open hearth furnaces rated at a capacity of 150 tons or more. In the more than two hundred open hearth furnaces in this country which are less than 100 tons capacity, it is difficult to average more than six tons of ingots per hour with no hot metal and eight tons of ingots per hour with hot metal.

Most of these smaller open hearths are, economically speaking, of relatively ancient vintage and it would be difficult indeed today to find any argument in their favor when compared with modern electric arc furnaces. The really modern open hearth today is usually two hundred tons or more in size with some installations having twice that capacity. These new large furnaces, installed in a modern plant equipped with every mechanical advantage and supplied with the most carefully selected and proportioned charge material and the best in fuel handling, probably represent the most economical method of producing large tonnages of carbon steel known today, especially when integrated with the bessemer for reducing carbon and supplying a molten charge.

To justify this statement the large modern open

hearth furnace must be directly connected to a modern blast furnace to supply it with the sixty per cent or more of hot metal required for its maximum economy. Thus with every modern large tonnage open hearth plant, a blast furnace with all its accessory ore handling equipment, coke ovens and coal handling must be considered part of the necessary investment. As a matter of fact, it has been insisted by some blast furnace operators that blast furnaces should always be operated in pairs to permit the necessary relining and rebuilding without seriously affecting open hearth production. Whatever the facts are, the installation of a new completely modern open hearth plant implies a tremendous investment not only in the melting facilities, but also in the necessary iron and coke producing facilities to provide the necessary hot metal.

The continuous decrease in the density of steel scrap over the past ten years has increased the desirability of the highest possible amount of hot metal (iron) in the open hearth charge, since the increase in charging time with decrease in scrap density is a most important factor in overall heat time. At the present moment there seems to be no immediate prospect of an improvement in open hearth charging scrap or decrease in charging time so that high iron charges will continue to be most desirable. The very low density of scrap will always be a serious handicap in open hearth operation, unless some faster charging method can be developed than the present box door charge arrangement.

It is quite apparent that the open hearth is economically at its best when it is above 200 tons in capacity, thoroughly modern in design and accessory equipment, and tied into an equally modern blast furnace plant for a high hot metal ratio to scrap in the charge. The smaller open hearth of less modern design with limitations in accessory equipment is under a considerable handicap, especially when hot metal facilities are absent or not the most modern. A study will make it quite apparent that the smaller open hearth furnace, operating with a high scrap ratio and on purchased cold pig iron in the charge, is so seriously handicapped by increased charging time, high iron cost, and high melting losses that it cannot economically compete with the modern arc furnace except when the industry is operating at the highest rate. This, together with the much higher investment involved, makes the installation of new cold metal open hearth melt shops a difficult thing to justify.

The electric arc furnace is used as a commercial melting medium for the production of every grade of steel from rimmed steel to high speed tool steel. For the purpose of this discussion we will consider primarily the comparative economics of the two types of melting furnaces when making the common carbon and low alloy grades of tonnage steels, thereby eliminating high alloy and tool steels now conceded to be most economically and properly melted in the electric furnace.

The relative differences in size are offset by the ability of the electric arc furnace, when properly powered and operated, to produce as much steel in a month as an open hearth of three or more times its holding capacity. This, of course, has an important effect on the relative investment in building, furnace and auxiliary equipment, but may be of very secondary importance in a large tonnage plant already producing open hearth steel.

The electric arc furnace operation lends itself better to tonnage pay incentive than the open hearth since the production is more affected on a time percentage basis by the time required to service, load, make bottom, etc., than is the open hearth under present conditions. This has worked out well in some plants where the tonnage incentive is so designed that production pressure is always maintained and the results compared to low or no incentive shops are very interesting.

If the incentive is based on a low enough tonnage rate so that the return to the melt shop crews is increasing at a satisfactory rate as the output passes the normal no-incentive tonnage, it will be found that a difference of two or three tons per hour will result. A high incentive alone does not insure maximum production; it must be combined with every modern mechanical help and the most experienced and understanding supervision.

A first requirement in a study such as this is an investigation into the general and fundamental economic factors which affect the choice of a melting unit. We find at the present time the steel industry under tremendous pressure to produce more and more steel of nearly every kind, so that in most cases order books are filled to the limit and it is difficult to get orders from new buyers even entered on the order books, let alone delivered.

Deliveries are relatively long, especially for an order which is in any way special or irregular. Many buyers without good priority rating are purchasing steel made outside the country and marketed through brokers and other intermediaries, which adds greatly to the cost. The high priority given defense orders and orders for long established and highly esteemed customers makes it difficult for many of the smaller and newer steel consumers to know with any surety when their necessary steel mill product can be counted on, and this has produced much discussion of the desirability of new steel mills or additions to present plant.

Also many relatively large buyers of steel in ingot, billet or bar form for further conversion have become alarmed at their relatively precarious condition in times such as these and are considering the desirability and economics of producing their own steel. The constant threat and what seems to be a fixed conviction in the minds of those in political power in Washington that a third world war of tremendous dimensions is just ahead of us makes all buyers of steel uncertain and apprehensive as to the future supply.

Thus there is in the minds of practically every steel buyer some uncertainty of his ability to keep his plant in full operation because of insufficient steel, if the present defense plans are carried through, and especially if another war of any magnitude develops. At the same time he feels that some time there will be a day when this period of high demand will be over and supply will far exceed any possible demand.

Never in the history of the steel industry has plant expansion been considered more seriously, and yet with so much uncertainty as to the effect of post war dwindling markets and almost overwhelming taxes.

During the present uncertain and difficult days during which deliveries in some steel products are uncertain and greatly extended and priority is a difficult thing to obtain, practically every buyer of semifinished steel on

a carload basis and even the buyer of finished steel in large tonnage has asked himself whether or not he should consider making his own steel.

Some have found relief in buying warehouse and "gray market" product, and some have found help by buying steel from abroad. Such means are, of course, only temporary and the writer has been asked several times to make studies of plants to produce 5000, 10,000 and even 50,000 tons per month of various products starting from scrap and getting to the finished product with the least investment and at production costs which still will make the final product competitive.

Such studies have covered seamless pipe and tube mills for northern Texas and in the north. They have covered mills to produce rods, mills to produce forging billets, bars, barrel stock, roofing sheet, alloy steel, carbon steel and steel in nearly every form, shape and for many uses.

The usual requirements were that the plant should be laid out to produce the final product in amounts from less than 5000 to 25,000 tons per month, that the plant should be located as close as possible to the final destination of the product and it should, with due credit for freight and handling charges, be able to deliver the product on a strictly competitive and, if possible, a highly profitable basis.

To complete such projects has required a careful investigation of markets, of equipment suited to the tonnage and other considerations involved, careful studies of freight and handling charges, and raw material economics and studies of availability of personnel and financing.

The market under present conditions and in an industrial area would mean any locality within two hundred miles, but for a more secure basis it was assumed that all the final product would be consumed within a radius of one hundred miles. Under present conditions, a freight advantage of one hundred miles is just about enough to pay the power and electrode cost on the electric furnace, and fuel and labor costs on the open hearth. This freight advantage is a valuable one and other things being equal makes some proposed steel plants more economical because of their location in respect to another source. However, materials, power, water and availability of potential personnel depend primarily on the location of the proposed plant.

There are in this country areas which normally consume enough steel to keep a small steel plant in operation, but because the primary needs are for carbon steel in small sizes, it is assumed that a small local plant could not compete profitably with the distant established producer even with the present high transportation costs. In the past and perhaps again in the future, steel producers have sold their product in relatively distant markets and have had to absorb freight to do it. The prewar steel industry was built on freight absorption determined by so-called basing points which permitted the larger fully integrated steel producers to sell steel in markets on a nationwide scale. The increase in freight rates and the decrease in pressure from competition made this practice undesirable and unnecessary. However, if the demand for steel decreases appreciably, the high freight rates will still limit the distance the buyer will go to get his steel if he pays the freight and they will limit the distance the steel producer can go and yet operate at a profit.

Transportation is a large factor in the cost of steel and accumulates to an important amount from ore to final product. To the large consumer of carbon steel in the more distant market, the higher freight costs will affect his ability to sell profitably in competition with others in his field that are located closer to a steel plant.

What is needed by such steel buyers is a mill capable of producing economically 50,000 to 100,000 tons of carbon steel per year in the form of hot rolled bars, rods, light structural shapes, wire, hoop stock and strip. The product would be used as it is or it would be used for conversion into cold drawn and wire products, screw machine stock, stamping and forging. Such a production is much too small for the conventional open hearth plant and large ingots, but fits nicely into the small ingots poured from electric furnace carbon steel and directly rolled on fast modern rolling mills into the finished product. Here the investment is only a small fraction of what would be required for the open hearth plant and the greatly increased yield and decreased conversion cost makes such steel plants when well designed and operated relatively quite economical and thoroughly competitive. Such mills are now in operation and demonstrating every day the soundness of such a practice. A very good example is the mill of the Connors Steel Co. in Birmingham, Ala.

With a really modern layout designed to produce semikilled carbon grades of billet type ingots from small but relatively high powered arc furnaces and convert them into rods, bars, and narrow strip on a modern combination continuous mill as at Connors, we have what is really a packaged steel plant which can be located in many steel consuming areas. Such a mill in combination with a warehouse can become the source of an economical steel supply of a fairly large group of local industries.

If power and melting stock are both available at a normal cost, such mills should also show an interesting return on the investment and in the years to come provide a simple means of decentralizing the steel industry which would be of at least military value in case of attack from without. Whether decentralization of the steel industry is desirable for any other reason than the military reason is hard to say. It is apparent that with the ever increasing widespread availability of power, fuel oil and natural gas, and the development of greatly increased density of population in Florida, Texas, the west coast and other less settled sections, the installation of modern well laid out steel plants based on the billet type ingot and the electric furnace as at Connors is certain to follow.

One of the great difficulties in the production of steel for its own use by a large consumer is the time and trouble involved in the engineering, erecting and getting into operation of even a small plant. Close to two years are required for the successful completion of such a program, and usually in a new plant another year or more is required to develop a hard hitting, well knit production organization.

Deliveries on large pieces of equipment require often many months and no one at this time can predict with any certainty when parts like special electrical control equipment will be available after the order is entered. Personnel are already spread thin in most operating

plants today, and it might be difficult to get together the necessary quality of supervision and operators needed to meet competitive requirements.

It is also most difficult to raise capital at the present time except in projects favored by the government and unless the capital is already available it might require a much longer time and more effort than would be practical.

Accordingly, the decision of any consumer to produce his own steel requirements must be considered most carefully with due thought given to the time and effort necessary to get into satisfactory production. This has been a strong deterrent to the setting up of steel producing equipment by steel users and promises to be more so in the future.

Supervision for a new plant is obtained usually by surveying the industry personnel and picking out men to build up the staff of the new company. The men selected are usually assistants or men in the larger plants who are ready to make a change and send in an application when the installation of the new mill is announced. It is necessary in many cases to get a certain man to offer him more money than the prevailing rate so that a new mill starts off usually with a mixture of higher paid men from other plants, and this increases the effort necessary to attain really profitable operation.

In all applications the question of scrap, power, fuel, and iron must be carefully considered no matter what the type of melting equipment, and no discussion can be at all complete which does not study the availability of these items with the greatest care. Before studying the raw material picture, however, we should compare critically the basic qualities of the modern electric arc furnace and the open hearth furnace and the factors other than investment and operating charges which are of interest.

THE MODERN ELECTRIC FURNACE AS A STEEL MELTING MEDIUM

By "modern" we intend to assume that any of the melting furnaces, either electric arc or open hearth, in this discussion are of the latest design intended to produce a given quantity of finished molten steel for the lowest practical cost and in the shortest time consistent with the quality desired.

We cannot limit the use of the adjective "modern" to the furnace alone because it implies that every detail and every auxiliary is modern. It means that everything from the scrap handling and charging bucket design to electrode clamps and temperature measurement represents the latest practice for the electric furnace, and everything from both scrap and iron handling to flue gas and roof temperature control represents the latest practice in the open hearth.

Power characteristics and electric controls have advanced to a new high point in the past year or two in the operation of the electric arc furnace, as have checker design, fuel burning and combustion controls on the open hearth.

In the electric arc furnace, to be modern in design means that the shell diameter and side wall height are sufficient to insure not only easy charging of the scrap in the shortest time, but to insure an average roof life of well over one hundred heats and a good side and back wall performance with the very minimum of delay due to patching or repairs between heats. This is an important factor in getting the very maximum tons from a given furnace per month. It is of course assumed that the furnace is equipped with an easily removable roof to permit top charging. The advantages of top charging are so well proven that, no matter how recent an installation might be, it must be assumed that the furnace is of a definitely obsolete design unless it is equipped with a well designed and practical means of roof removal when needed. Door charging might be thoroughly practical and economical in smaller sizes or for applications where the final product cost is high enough to make the actual cost (including delays) of door charging a much smaller percentage of the total than with top charging. Even this is debatable where the extra time required is measured in loss of the more valuable finished product. In the tonnage field, the top charged furnace with removable roof can be considered as standard.

The charging bucket should be designed as large as is practical for the volumetric capacity of the furnace with due regard to the most desirable recharge volume. The old method of using a rope, which requires several minutes to be burned off, for holding the bucket bottom segments closed represents a practice which has been replaced in the modern plant with mechanical bottom locks which can be tripped from the floor or by the crane.

In the really modern electric furnace the height and diameter of the shell should be designed to permit a full sized charge of the present day poor grade scrap to be loaded in not more than one recharge. More than one recharge has a very important effect on prolonging the time of the heat and shortening the life of the roof and lining. Every possible care should be taken to reduce recharging and prolonging roof and side walls life in the design of the arc furnace. If this is done voltages up to 450 can be used with amperages up to the limit of the electrodes.

The more modern arc furnaces are being designed to carry much higher input power than was formerly thought practical with a resultant increase in tons per hour, and an important decrease in power, labor and electrode costs per ton. The power input is actually limited by the carrying capacity of the electrodes so it follows that the electrodes should be as large as is practical. The lower current density of the larger electrode results in lower temperature and consequent oxidation losses, and also results in less delays and much less need for the operators working on the furnace roof. After the current limitations of the electrodes are established, increased power is obtained by increased voltage so that as the trend for increased power develops so does the trend for increased secondary voltage. This is especially beneficial when melting the modern low density high resistance scrap. What the top secondary voltage will be in the near future is hard to say, but the trend for higher voltages will continue with the top tap voltage exceeding considerably the 450 volts now about the maximum.

The modern arc furnace is equipped with graphite electrodes which are as generous as possible in diameter, equipped with well designed power clamps and counterweighted to prevent electrode breakage when nonconducting material is present in the scrap. This is a fairly common occurrence in the remelting of pit scrap

in which refractory material such as slag or bricks is present.

It is my opinion that the really modern arc furnace should be designed and powered so that a full heat can be melted flat in not more than ninety minutes with a single recharge. This would make possible the making of single slag carbon heats in less than three hours tap to tap or on a sixty-ton charge an average production of twenty tons per hour.

If a plant is fully integrated with hot metal available and all the accessory equipment already installed and the problem is one of adding to present large open hearth equipment, there seems to be only one answer and that is to add more open hearth capacity. An interesting case comes to mind, however, of a large Canadian open hearth plant which added a large electric melting furnace to its open hearth line and serviced it with the regular open hearth equipment. This electric furnace was installed because building space did not permit the installation of another large open hearth and by installing the transformer on the outside of the building, it was possible to put in an electric furnace. It was stated after some years of operation that the electric furnace was producing carbon steel on about the same economic basis as the regular open hearths and was giving a very good account of itself.

Electric furnace operators who have had hot metal available and have tested charges up to 50 per cent hot metal claim that this improves production and cuts power and charge costs under present conditions. It is claimed by operators who have operated both electric furnaces and open hearth furnaces with hot metal in the charge, that the hot metal is an ideal addition to the electric furnace charge up to at least 50 per cent and the arc furnace is especially suited to such charges because of its high rate of carbon removal.

For a hard pressed steel plant which needs more ingot capacity, but has to build a new melt shop for it, there is required a little more consideration of this problem if the most suitable type of equipment for melting is to be correctly determined. If hot metal is available, the probable charge material cost and the cost above material for melting will be lower with the large open hearth than with the large all-scrap charged electric furnace. This is because with good blast furnace operation and a high iron charge in the open hearth, the charge cost should be at least $5.00 per ton of ingots lower than the all scrap electric furnace charge. This statement is made with considerable reservation because of the distinctly lower metal (iron) recovery from pig and scrap in the open hearth as compared to the electric furnace. This loss varies considerably with the conditions of the melting, the size and sharpness of the open hearth and the power and size of the electric furnace. The modern electric furnace in the fast melting of the usual quality of scrap now available will recover from two to five per cent more iron from the charge than the large open hearth with hot metal and scrap. This difference varies greatly and increases as the melting rate decreases.

With the large open hearth furnace operating on high iron hot metal charge, the cost of melting and finishing is lower usually than with the medium powered large all scrap charged electric furnace. This difference decreases as the power and voltage of the electric furnace increases and as the quality of the scrap decreases. In some cases of extra high voltage and power, the modern top charged electric furnace is producing semikilled carbon steel at a cost per ton above charge which is lower than any but the best large open hearth melt shops.

Thus we might assume that if he discounts the future and bases his selection entirely on present conditions, the large fully integrated open hearth steel producer will increase his melting capacity by the installation of more large and modern open hearth equipment. This involves no change in his thinking or in his material problem, and simplifies his problem of operating labor on the new furnaces. With the operator of open hearth furnaces in the so-called semi-integrated plant who has to depend on cold pig iron and scrap for his charge, the picture is different, especially if his furnaces are relatively small and less efficient than the larger fully integrated plant.

THE PROBLEM OF RAW MATERIAL

One of the most important factors in the economics of both the open hearth and the electric furnace is the high cost of the basic raw materials. Scrap is particularly unstable in price, and while hot metal and fuel have also increased greatly during the past ten years, they tend to drop less in price with low demand. Power compared to other supplies has been relatively stable, and this stability has been an important factor in improving the economic position of the electric arc melting furnace. As generating stations increase in size and power networks become wider spread, the availability and economy of production increase and it is possible that the electric furnace will find its fuel base rate costs quite stable over the years ahead.

Scrap is subject to wide fluctuations in price as the demand varies from light to heavy. Its price depends apparently entirely on the demand and varies from all that the market will stand when the demand is high to whatever is offered for it when the demand is low. It is usually subject to much handling and transportation costs, which have increased greatly during the past few years and unless the demand decreases greatly there does not seem to be any chance for much softening in the period just ahead. The great increase in the electric furnace capacity, and the shortage in iron production has increased to the very limit the demand for scrap. At the present time, the high cost of scrap at the furnace and the inability to increase the supply promises to be the principal obstacle in the path of steel plant melting expansion, especially that of the electric furnace.

If the price of scrap follows trends of the past, it will drop quite rapidly with any important decrease in demand. Such a decrease in demand will come with a considerable increase in blast furnace capacity and a general decrease in steel production. Due to its large dependence on freight rates and highly unionized labor costs, it is difficult to foresee any very important decrease in hot metal costs even with a considerable decrease in operating rate. On the other hand scrap will drop to a much greater degree with decreasing operating rate so that the differential in cost between iron and scrap should be in the future much greater than in the past. This will improve to an important degree the

relative economy of the electric arc furnace as compared to the open hearth in times of low operation. At the same time, the ability of the electric furnace to be easily and simply started and stopped to meet any low operating schedule makes it most desirable in a time of low operating rate with its fierce competition.

Unless a way is found for increasing the supply and decreasing the cost of scrap, any important expansion of electric furnace melting would be difficult to justify. The installation of new furnaces in areas where scrap is more available than the present steelmaking centers will only serve to increase the price of scrap in those areas and decrease the supply of scrap in present steel producing areas. Having given a great amount of time and study to this subject, it is the opinion of the writer that the only way out is to develop a competitive source of iron for present day scrap which will serve to stabilize the cost of the scrap charge in the melting furnace at a figure close to the present cost at the blast furnace of hot metal.

This can be done in several ways, the most promising of which is the combination of the newer natural gas cracking furnaces with the low temperature reduction of iron ore concentrates. The pilot plant operation of such a reducing method based on the work of Udy and Lorig was completely successful and waited only on the development of cheap hydrogen for its reduction to practice. With the newer methods of cracking of natural gas, hydrogen at a sufficiently low cost is available to insure a highly competitive source of low carbon iron for the electric furnace charge.

A field which should also be thoroughly explored is the direct reduction of iron ore concentrates which have been sintered with sufficient coke to remove the oxygen from the iron oxide. Here it is important that the iron ore and coke be closely held together mechanically to keep the coke in contact with the ore as it is heated under the arc. The coke becomes heated to a temperature approaching that of the electrodes and its reaction is fast and complete, providing the coke-ore contact is maintained. The trials made indicate a power consumption much lower than would be first expected, probably due to the high degree of formation of carbon dioxide. This method of ore reduction offers highly interesting and remunerative possibilities.

COMPARATIVE OPERATING ECONOMICS

We might attempt to estimate the direct operating costs of an open hearth melt shop and an electric furnace melt shop of comparative tonnage to determine what the relative economics seem to be.

In making an actual comparison between the operating cost of an electric furnace and an open hearth to produce the same tonnage of carbon steel per month, it is difficult to develop anything but estimates of what such costs would be when both types of furnaces represented the latest in design and operation. This is because the operating costs will vary considerably with the local conditions, and what would be an ideal location and operation for the open hearth melt shop might be quite the opposite for the electric furnace shop, and vice versa.

The availability of low cost hot metal and heavy melt scrap is vitally important to the open hearth, as is a favorable power rate and available power to the electric furnace. Power rates per kwhr vary greatly from one part of the country to another, some shops paying only five mills per kwhr for off-peak operation plus a coal adjustment charge which brings the total to less than five and one-half mills. Other shops have to pay up to ten mills average for power based on full time operation and this means that there is possibly a great difference in the cost of power (fuel) from one plant to another. Power is the principal item of expense in the operation of an electric arc furnace, and depends to a large degree on the type of steel, the voltage and transformer capacity, the average power factor, and the furnace size. Single slag carbon steel of the semikilled type is being made in a few large furnaces with an average power input per net ton of 475-500 kwhr. With larger furnaces and higher meltdown voltage and really modern equipment and control, it is possible to produce steel at close to the 475 kwhr figure. With standard voltage and the present day average furnace the power required for semikilled steel should average between 500 and 525 kwhr per ton. Thus it is possible to find in operation arc furnaces which show a power cost per net ton of less than $2.75 while others show a power cost of more than $5.50 per net ton. While the latter cost appears high under some conditions it still will permit competition as compared to the open hearth. Even with $5.00 for the power cost for ingots it is possible in making semikilled carbon steel to attain in the modern arc furnace a cost above material of less than $14.00 if the production rate is high enough.

A most excellent discussion of the economics of producing carbon steel on a large tonnage basis is presented by C. F. Ramseyer in the June, 1951, issue of the Iron and Steel Engineer. Here the factors which enter into the production cost and investment required of a really modern high tonnage carbon steel melt shop are developed in some detail.

It is his conclusion that in competition with the modern open hearth, the electric arc furnace can produce carbon steel ingots more economically than the cold iron open hearth and if hot metal is available for either the electric or open hearth furnace the cost of production will be approximately the same.

This is a rather revolutionary conclusion when it is realized that the investment required for the most modern electric furnace melt shop is about half that of the equivalent capacity modern open hearth plant. It means that in the future, any new melt shop design, no matter how large, will have to give most serious thought to the electric arc furnace, and that in view of the greatly reduced investment required, those responsible for financing will probably lean heavily toward the electric arc furnace.

As a check on Mr. Ramseyer's statements that in a cold melt shop the electric arc furnace can produce steel more cheaply than the cold metal open hearth plant, we might study the estimate for a plant to produce approximately 25,000 tons per month of semikilled carbon steel ingots. Here it was desired to determine what would be the relative investment and product cost of a modern electric arc melt shop and a modern open hearth plant using cold pig iron as the iron charge.

Two 20-ft arc furnaces equipped with 20,000-kw transformers were recommended or four 150-ton oil fired

basic open hearths. The high powered arc furnaces should have no trouble in meeting the requirements of an average of 12,000 tons per furnace per month in spite of normal delays. Three of the open hearths might under exceptional conditions produce this much steel but under normal conditions four would be required.

The investment required would be approximately as follows; the exact figures vary greatly with the times and depend on market conditions at the time the plant is started.

Capital cost of two-furnace melt shop, 20-ft diam furnaces, 300,000 net tons per yr.

Furnaces, transformers, switchgear foundations, installation	$1,100,000.00
Charging equipment, molds, stools, electrodes and initial inventory, ladles, spares, etc	400,000.00
Cranes, scrap and slag handling, buckets, stripper, etc	625,000.00
Building	550,000.00
Total	$2,675,000.00

This estimate covers the direct melt shop only and does not include scrap storage or yard or ingot transportation. It does not cover ingot handling facilities or floor machine charging equipment.

The open hearth layout is for the same tonnage capacity with four 150-ton furnaces and standard floor charging equipment and charging boxes. The investment required would be approximately as follows, the exact figure depending on market conditions at the time the plant was started.

Capital cost of four-furnace melt shop, four 150-ton OH furnaces, 300,000 net tons per yr.

Four 150-ton oil fired furnaces installed	$3,000,000.00
Charging equipment, molds, stools and initial inventory, ladles, spares, etc	625,000.00
Cranes, scrap and slag handling, boxes, stripper, etc	825,000.00
Building	925,000.00
Total	$5,375,000.00

These estimates would indicate that the cost of the open hearth installation ready to operate would be approximately twice that of the same capacity electric arc furnace installation.

Part of this increase in cost is due to the larger cranes and craneways required to handle the larger heats. Part is due to the greater space required for the open hearths and checkers. Some of it is due to the larger and heavier buildings, the special slag handling equipment and the larger investment required for charging equipment.

The cost above charge can be estimated quite closely from available operating records. When concentrated on common carbon grades, and with the necessary incentive bonus, high powered really modern 20-ft diam electric furnaces should be able to produce 25,000 net tons per month of ingots for approximately as follows:

Electric furnace operating cost above material, two 20-ft diam arc furnaces, 300,000 net tons per yr.

Power and electrodes (8 mil power)	$ 5.60
Molds and stools	1.25
Fluxes	0.50
Ladle, brick, stoppers and nozzles	0.15
Labor and supervision	1.65
Repairs and maintenance	0.30
Refractories	0.55
Chemistry and metallurgical laboratory	0.25
Supplies, tools, etc	0.25
Utilities	0.25
Yard switching	0.45
Provisions for rebuilds	0.55
Other	0.25
General expense	1.50
Total	$13.50

These figures total fairly close to what is being obtained in some representative plants producing single slag carbon steel heats, but they are of necessity only tentative for a new plant and will vary from operation to operation.

The open hearth cost above material for a cold iron plant of four 150-ton oil fired furnaces is estimated as follows. The values given are also naturally tentative but generally speaking compare closely with costs of some open hearth plants now in operation.

Open hearth operating cost above material, four 150-ton furnaces, 300,000 net tons per yr.

Fuel	$ 3.30
Molds and stools	1.20
Fluxes	0.50
Ladle, brick, stoppers and nozzles	0.20
Labor and supervision	2.00
Repairs and maintenance	0.50
Refractories	0.70
Chemistry and metallurgical laboratory	0.20
Supplies, tools, etc	0.40
Utilities	0.40
Yard and switching	0.70
Provision for rebuilds	1.60
Other	0.50
General expense	1.60
Total	$13.80

Thus we seem to have the operating cost above material in favor of the electric furnace, but the difference is very little and depends to a large extent on the cost of power in the particular district in which the melt shop will be located.

One of the most important factors in the operation of the fast melting high powered modern arc furnace is the reduced effect of decrease in furnace capacity on melting costs as compared with the open hearth. The arc furnace is inherently, due to its design, a furnace of high thermal efficiency and the heat input cost per ton does not increase nearly as fast as the size is decreased, as would be the case with the open hearth. While the high powered arc furnace melting 10-ton heats does increase in melting cost per ton as compared to a 50-ton arc furnace, the increase is much less than would be the case of a 30-ton open hearth as compared to a 150-ton open hearth.

In making 10 and 15-ton carbon steel heats, the electric furnace is able in pouring billet type ingots for direct rolling into rod or bar stock to compete economically with the 150-ton cold metal open hearth. In fact it is in this field that an important tonnage of future electric furnace capacity lies. The relatively low investment in the small electric furnace, the accurate control, and the high production rate, overcome whatever advantages the open hearth has in size and lower cost fuel.

One of the principal items in the cost of steel production in the cold iron open hearth furnace is the price paid for basic pig iron. This is, at the present time, considerably above scrap in most plants and with its higher losses in melting will bring the average cost per ton of ingots of the charge of the open hearth to approximately $5.00 above the cost per ton of ingots of the electric furnace all scrap charge. While there has been no fixed rule that scrap should be cheaper than open hearth furnace iron, a study of the scrap and basic iron prices over the past twenty years will indicate that uncertain as the price of scrap is, it seems to maintain a price which is close to $5.00 per ton less than basic pig iron. This, if it continues, will make a difference in operating cost between the cold metal open hearth and the electric arc furnace which makes the operation of the open hearth exceedingly unattractive.

When an open hearth plant is operated in connection with its own blast furnace, the charge cost is definitely in favor of the open hearth. With present coal prices and transportation costs, hot metal at the blast furnace is approximately $20.00 per ton under purchased cold scrap prices at the furnace, and this, together with the value of the contained heat, makes it definitely difficult for the all scrap electric arc furnace to compete with the hot metal open hearth shop. In future periods of low production and strong competition, the price of scrap if it behaves as usual might drop below hot metal costs and make the electric furnace operation attractive. If, as Mr. Ramseyer shows, the electric arc furnace on hot metal is distinctly competitive with the hot metal open hearth, then the economic position of the open hearth becomes uncertain indeed.

One field of development for the electric arc furnace lies in its production of thin slab ingots and their direct conversion into hot bands or sheets by single stand hot strip mills in combination with single stand cold mills. Such a combination offers what appears at this time to be about the lowest cost mill that is possible to make flat rolled products.

The electric arc furnace is better adapted for producing rimmed steel product than the large open hearth because of the higher iron oxide possible and better temperature control. In the semikilled carbon field the same is true with the better furnace regulation and control resulting in remarkably high quality ingots which are on the average also definitely better than the open hearth. This statement assumes, of course, that with both furnaces the operators are thoroughly skilled in the fine details of producing the best rimmed or semikilled ingots.

In the making of thin slab ingots of the highest quality, a special semikilled or killed carbon grade is used which must meet, for practical consideration, two requirements. These are:

1. The maximum thickness of metal to be solidified should be under four and preferably three inches.
2. The minimum rate of pour should be approximately one ton per minute.

These requirements must also be met in the continuous casting of ingots if the process is to be on a tonnage scale. This means that the logical shape for continuous casting is a slab section of not over four inches by whatever width will give the mill the desired width and still meet the minimum pouring rate.

The electric furnace, because of its size and ability to tilt, lends itself more easily and more economically to the operation of a continuous casting machine than does the open hearth of three times its size. Apparently the slab is the shape best suited to cast continuously, and when poured in a manner where sticking is prevented should give a product satisfactory to a single stand hot strip mill for direct conversion.

We have here a means for providing economical production of relatively small tonnage of hot rolled bands in areas where the fully integrated mill usually considered necessary for this type of production would be most difficult to operate. It is quite possible that the continuous cast slab will not only be used for hot bands but by means of dividing rolls may be made to produce billets as well. There is thus possible in the electric arc furnace a combination with the right type of continuous casting equipment which will make possible a mill for rolling the cast slabs directly into hot bands with no important investment in a blooming mill. With the same equipment and a mill with dividing rolls, billets could be produced if desired.

The electric arc furnace has proven itself to be definitely superior to either the open hearth or the bessemer furnace in the production of high sulphur steels made especially for improved machinability. With the medium manganese (1 per cent) type, with added sulphur above 0.25 per cent it was found several years ago that the production and machining quality was greatly improved by the entire elimination of silicon and aluminum as additions to the heat and by maintaining an iron oxide content in the tapping slag of at least 30 per cent. The elimination of the aluminum and silicon additions was to reduce the presence of inclusions in the steel which would be abrasive to the cutting tool. The high iron oxide resulted in a product which required much less conditioning than any other tonnage steel rolled on the mill. In fact the high yield resulting from the high quality semikilled ingots and the practical absence of conditioning gave a hot rolled product in 1-in. rounds which compared better than favorably in cost with the same grade made in either the open hearth or bessemer furnace. The improved machinability and the low conditioning cost made this electric furnace product definitely much more economical to produce and market than its competitive open hearth or bessemer product. This is in spite of the fact that the electric furnaces used were not especially modern in design or high in power.

SUMMARY

Primarily due to increase in open hearth operating costs and investment charges in recent months, and the improved design and operation of electric arc fur-

naces with more stable power costs, the modern arc furnace can, under most conditions, compete economically with the modern open hearth.

It has a definite advantage in meeting smaller production requirements where cold melt open hearth furnaces would be used.

While the economic operating advantage of the electric furnace is greatest in the production of alloy and fully killed carbon steels, it can hold its own without difficulty in semikilled and rimmed carbon steel production when in competition with the cold iron open hearth.

In combination with the billet type carbon steel ingot practice (and continuous casting) and the fast continuous mill for direct rolling of these ingots into strip, small bars, rods and shapes, the modern electric arc furnace can compete with almost any of the open hearth plants now operating. This is especially true when the electric furnace, billet type ingot and continuous mill combination is set up in a steel consuming center which is located at some distance from the fully integrated open hearth plant.

There is even strong evidence that a modern high powered large volume arc furnace when operated on the same hot metal-scrap and ore combination as the large open hearth can show equally low costs.

The apparently favorable production economic picture of the modern arc furnace is accompanied by a sharp decrease in investment requirements as compared to an open hearth furnace of equal capacity. This is especially true of the electric furnace plant built to produce carbon steel for small or billet type ingots designed for direct conversion to small section product. Here the saving over a finished product based on the large ingot is marked, as is the overall investment required.

The greatest handicap to electric furnace expansion at present is the scrap scarcity and consequent high cost. Unless the problem of finding a lower cost charge material with a consequent decrease in scrap cost is solved, the installation of many new electric furnaces will soon be considered economically unwise.

This problem can be solved but will probably require a cooperative development of the low temperature reduction of iron ore concentrate with hydrogen. It also appears possible that the reduction of sintered iron ore concentrates by intimately mixed carbon in the arc furnace may be under certain conditions economical.

DISCUSSION

PRESENTED BY

C. W. CRAVENS, Assistant Superintendent of Open Hearths and Electric Furnaces, Republic Steel Corp., So. Chicago, Ill.

J. R. MILLER, Ramseyer & Miller, Inc., New York, N. Y.

A. J. FISHER, Assistant Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

C. W. VOKAC, Manager, Hydro-Arc Furnace Dept., Whiting Corp., Harvey, Ill.

H. W. McQUAID, Consultant, Cleveland, Ohio.

C. W. Cravens: Mr. McQuaid deserves credit for the manner in which he tackles such a comprehensive subject and one which embodies so many ramifications. Since I am jointly responsible for the ingot output of four 250-ton tilting open hearth furnaces, eight 70-ton conventional electric furnaces and one 70-ton top-charge electric furnace, I must look at this subject without bias.

The size of the investment in a modern melt shop depends entirely on the method of melting procedure to be employed, since this factor governs the amount of auxiliary or complementary equipment required. Whether the melting is to be based on converting straight scrap, a combination of scrap and cold iron, scrap and hot metal, or scrap-blown metal and hot metal, the original cost would greatly favor the electric furnace installation. This is due to a decrease in such requirements as ground area, excavation, shoring and footings, building size, structural steel and refractories. Taking into consideration the above factors, the original investment required for an electric furnace installation, embodying identical melting features, would be approximately sixty per cent of that required for the modern open hearth installation.

The adaptability of the modern furnace to market conditions depends on its size, furnace availability, production, the ability to vary charges and to be capable of operating economically during adverse or quickly changing market conditions. The modern electric furnace does not have to be as large in size to compete with the modern open hearth in tons per hour and total production. This feature reduces the problem of combining a number of orders to make up one heat of steel. The top charge furnace is decidedly advantageous in charging the poorer grades of scrap. The outlook on obtaining good scrap is a dim one today and grows worse with every ton of increased capacity. Under present conditions, where production must be at its peak and where furnace availability is of utmost importance, the electric furnace can be counted on for ninety-eight per cent. The modern arc furnace will outproduce those open hearths employing cold iron practice and will compete evenly with present open hearths approximately three times their size. Where it is necessary to vary the charge in a furnace due to availability of raw materials or to take advantage of shifting costs, the electric furnace is most favorable. During a period of unstable market conditions, it is often advantageous to reduce the furnaces operated if such reduction does not entail considerable cost in furnace repair. The electric furnace is especially favorable under these conditions since they can practically be shut down and started at will without abnormal repair. Due to their smaller size and their ability to produce all grades of steel, it lessens the burden of accumulating orders for a heat and enables a company to better serve its customers.

The cost of production generally is divided into two parts, that of the materials required and that cost necessary to change those raw materials into ingot form. From our own limited operation it is certainly practical to assume that the electric furnace can use the same type raw materials such as scrap, ore, sinter, pig iron, hot metal, blown metal, stone and burnt lime, as the open hearth. The same care is required in making up a raw material burden conducive to low cost ingots, but it can be done. The use of poor scrap, sinter and low grade ores is costly to the open hearth but does not

prove as severe a burden in the electric furnace. Therefore from a raw material standpoint the electric furnace is in a good economical position.

The cost above material is composed of such items as fuel, fluxes, supervision, operating labor, refractories, ladle stoppers and nozzles, refractories repairs and maintenance, chemical and metallurgical laboratory, supplies, molds and stools, yard switching, provision for rebuilds, general expense, etc. In the comparison of such items, the greatest difference shows up in fuel. This difference is not actually as great as it appears, since credit is not shown on the electric furnace cost sheet for the advantage gained throughout the plant for a lower power rate. The demand increase in power caused by the furnace certainly lowers the unit cost of power to all units. While it has not yet been possible to actually operate the modern electric under all identical conditions as that of the modern open hearth, where such conditions have been duplicated, the proof that the modern electric can compete economically with the open hearth is there, and it is reasonable to assume that it will continue regardless of the set of identical conditions on which they are compared.

Certainly, a steel producer, whether increasing production in the present shop or contemplating an entirely new shop, cannot afford to sell short the modern electric furnace.

J. R. Miller: Since we are talking about a comparison of the electric furnace versus the open hearth, I think it is important to point out that we are dealing with two things which are at present at two entirely different phases of their development. In the past 50 years, the open hearth has been developed into a superlative piece of equipment which is now near the peak of its potential. The electric furnace, up until recently, was looked upon mainly as a medium for special high grade and alloy production, and it is only within the past ten years or so that it has been seriously considered as a means for producing ordinary steels. If we think for a moment about the typical growth curves of each of these units, we find them very similar to many of the open hearths; moving up slowly in the early stages of development, then shooting up sharply, and finally bending over into a flat, horizontal line. There is this difference—the open hearth lies far beyond the knee of the curve, within the steady period representing, let us say, nearly full maturity, while the electric furnace is just entering into the rapidly rising period of development and improvement.

We should therefore, consider some of the inherent characteristics of these steel-making units. Mr. McQuaid, in his preliminary remarks introducing his paper commented that it seemed to him from the open hearth discussion that all that was needed to better the open hearth was to increase melt temperature by adding more burners. Unfortunately, it is not quite as simple as that. It is a characteristic of the open hearth furnace that the ratio of area which is in contact with the flame to the total surface area of the bath is very small, and that furthermore, the transferred energy must fight its way through a layer of slag. In the electric furnace, the relation of surface through which heat transfer to the bath is made, to the total surface is very much greater; and there is here a direct arc contact between the electrodes and the metal. Of course, you can try to put in more burners or apply higher flame temperature, but again we run into a definite physical limitation in the open hearth. You have to get the waste products of combustion away and the quantities of these gases which can be handled are definitely restricted by the size of flues, checker-chambers, etc. Such a situation does not hold in the electric furnace.

There are other advantages which the electric furnace has inherently over the open hearth. One of the most striking of these is its considerably greater thermal efficiency. If we compare 500-kwhr per ton of steel for the electric with say, 28 gallons of oil for the open hearth, we have an equivalent requirement of 1.7 million Btu's in the electric furnace as against twice that amount in the open hearth. It is true that at present the difference in the cost of these fuels makes the cost of electrical energy plus electrodes greater than that of the oil required in the open hearth per ton of steel. But the development of larger electric melt shops requiring sizable blocks of power at high demand factors, or perhaps the erection of the necessary power generating units, as well as rapidly dwindling oil supplies, could change this picture in the near future.

Of course, improvements in the open hearth will continue to be made. The very interesting results recently reported on the use of oxygen may perhaps be followed up generally in the industry, or furnaces above the presently popular 275-ton units for new installations may become common, but essentially the main areas for open hearth improvement seems to lie in the field of material handling. The electric furnace is relatively still in its adolescence, with many more opportunities for further development. Improvement in raw materials for electrodes and in their design; increase in shell diameters from the present maximum of 22 to 24 feet and ever greater sizes with heats up to 150 tons and perhaps more; the use of 30,000 and 40,000-kva transformers; longer refractory, roof and sidewall life even with the greater power, are just a few of the things which will surely come.

I cannot therefore, agree with Mr. McQuaid's statement that the electric furnace must take a back seat to the large open hearth. For the present perhaps it must, but I do not think for too long a period. In the current period of rising costs, it is essential that some way be found to keep steel ingot costs down to reasonable levels, and the electric furnace, properly developed, presents a far greater means to do this than the open hearth. I think this is the main conclusion that we as engineers and operators in the steel industry can reach in considering the comparative economics of the electric furnace versus the open hearth.

Finally, I would like to note that we have been speaking about electric furnaces for about 45 minutes with hardly any mention of the use of hot metal. It was mentioned briefly, that one operator used hot metal charges in his electric furnaces occasionally with favorable results. I think this matter of hot metal should not be overlooked. Mr. McQuaid stated that little by little we are discovering that we can do practically anything in the electric furnace that can be done in the open hearth, and I believe that this is quite universally accepted today among steel makers. We can therefore look forward to the use of greater and greater quantities of hot metal in the electrics. This is very important

since it is the practical solution to the scrap shortage problem which Harry mentioned, and in addition will result in sizable reductions in power requirements and melt times. We, in our office, are now designing a small integrated plant for South America which will include two electric furnaces operating on 50 to 70 per cent hot metal.

A. J. Fisher: I would like to call attention to something which has not been brought to light in the consideration of the electric versus the open hearth furnace. I am speaking now of the large, integrated steel plants in which there are coke ovens and blast furnaces in which by-product fuels are made and are available for plant use.

Through the work of fuel engineers and other allied engineers in our plants, we are finding that the by-product fuels are making our plants more or less self-sufficient in respect to fuel, and that very little purchased fuel is bought. When you consider the electric furnace you have the problem of what you are going to do with the by-product fuels. These are coke oven gas, blast furnace gas, and tar or pitch.

When you put in an electric furnace, you immediately must decide whether you can sell these by-product fuels, whether you are going to bleed them, whether you will generate power with them, or whether you are going to purchase power. If you decide to sell as much of the by-product fuels as possible, and then install a generating station, you will find that it will cost from $200 to $250 per kw. If you add the cost of the power generating station to the electric furnace, you will undoubtedly find that the balance becomes in favor of the open hearth process.

However, in small isolated plants where there is no by-product fuels and where there is a lot of scrap available, I can see that the electric furnace may have the advantage.

C. W. Vokac: Mr. McQuaid mentioned the natural life curve and the possible relative positions of the open hearth and the electric furnace on this "S" curve. I would like to see such a curve developed for both.

Another point mentioned by Mr. McQuaid was dust control. Since the electric furnace uses the most perfect metallurgical fuel (electrical energy), the volume of gases emitted from an electric furnace, per ton of metal produced, is only a small fraction of that from an open hearth. The temperature of the gases from the electric furnace is also considerably lower. As a result, the filtering of the electric furnace gases is materially simplified.

One foundry equipment builder made an extensive study of dust and smoke collection on cupola stacks in the Los Angeles area where the local code requires a high efficiency from such collectors. This study indicated that the most practical collector for such restrictions is the baghouse type using glass type impregnated bags. Experience gained here was applied to electric furnace equipment and one experimental unit is now being tested in a foundry in the middle west. Results already obtained indicate that electric furnaces, properly hooded, and equipped with this type of collector will be able to meet the most stringent codes, and since the volume and temperature of the gases filtered is relatively low, the cost of this added collector equipment is also relatively low.

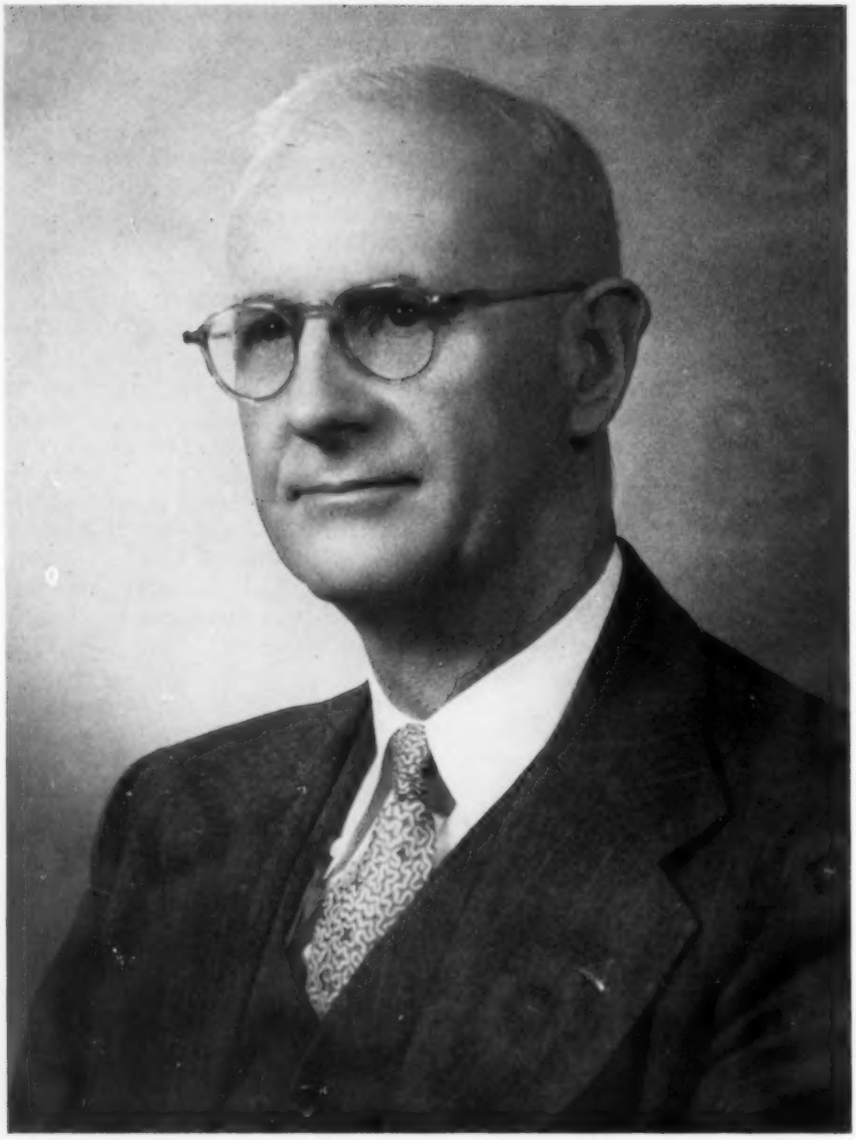
Another speaker mentioned that there is no limit to the amount of current an electric furnace can use. I believe he meant this in a comparative sense, since the statement does need qualification. Though the current values an electric furnace can use are high, there are factors that definitely limit the amount of current any size furnace should use. For instance: with 60-cycle alternating current exceeding 40,000 amp, the inductive effect and resulting losses begin to mount and the practicability of higher values may be questioned. The inductive effect of alternating currents of lower frequency is less, so higher current values in these cases may be used. For 50-cycle current a comparable value would be closer to 50,000 amp and for 25-cycle current, 100,000 amp. There are other factors also such as availability of electrodes large enough to carry the current, copper investment in the circuit, etc.

An interesting question often asked is: "Since the frequency of the current limits its use why not use direct current which has no frequency?" This could be the answer if an economical means could be developed that would supply to the furnace such current in sufficient amount. Until such a means is found, the alternating current will be preferred.

Current alone does not mean Btu's. It takes the multiplied combination of current and potential (voltage) to put heat into the furnace. The next popular question is, therefore, "Is the voltage that a furnace can use also limited similarly?" The answer is no, but there are practical limitations here also that become compromising and must be taken into consideration. Among these are safety to personnel, refractory life, electrical, thermal, and mechanical qualities of insulations, etc. A compromise for some of these factors that results in increased production from a unit may be economically justified but compromising on safety is questionable. Potentials as high as 500 volts are being considered today as economically feasible. Using this figure and that mentioned for the 60-cycle current, the transformer capacity would be 35,000 kva. Is this the maximum size of arc-furnace transformer? Can present day power circuits handle more, and of this type of, load? Are additional provisions required? Will these be economically justified? These are the current questions.

H. W. McQuaid: In Mr. Miller's discussion he stated that he could not agree with my statement that the electric furnace must (economically speaking) take a back seat for the large open hearth. It is my belief that this will be the situation where a really modern, fully integrated plant, accessible to its own coal and iron ore mines, is already in operation, especially if the original investment was in pre-1940 dollars and the plant is relatively close to its markets. Even in this case, the final profit per ton of ingots is usually less than with some of the modern semi-integrated plants as a study of annual earnings per ton of ingots will show. Much of this poor showing in the fully integrated plant is due to its high percentage of product which is sold in larger sizes as semifinished product.

As the center of population moves further toward the west and southwest and the delivery costs increase, the need for a more decentralized steel industry will increase and the answer to this demand will be in the fast melting, more efficient, modern high powered electric arc melting furnace.



I. N. Tull

PRESIDENT, 1952

ASSOCIATION OF IRON AND STEEL ENGINEERS

I. N. TULL was born in Anniston, Ala., reared in N. C., and graduated from North Carolina State College in electrical engineering in 1910. After a brief period of telephone work, he entered General Electric Co.'s test course at Schenectady. He was transferred to their Cleveland office's engineering department in 1912, remaining there until 1915, when he was employed by Corrigan, McKinney and Co. as electrical engineer. The next 12 years were spent in engineering and construction work as that company built blast furnaces and a steel plant at Cleveland, Ohio and proceeded with extensive electrification of their iron mines and the opening of coal mines. In 1927, general supervision of electrical maintenance and operations was added to the construction duties. After the merger with Republic Steel Corp. in 1935, Mr. Tull became electrical superintendent of the Cleveland district for Republic. He is also chairman of Republic Steel Corp.'s electrical committee.

The President's Message

I feel very humble, and very proud too, at having been chosen President of the Association of Iron and Steel Engineers. Looking backward through the years of accomplishments of its members makes me realize what a challenge is presented to each incoming administration.

For some 20 years, our membership has embraced all branches of engineering in the steel industry, and consequently we have been able to meet our problems and obligations more efficiently than before. There is still room for improvement, and that improvement can only come through proper effort and active participation of each member, committee, director and officer, and of the staff. Our new members are welcomed in the hope that they will enter into our activities freely for their own gain and for the ultimate benefit of the iron and steel industry.

One definition of an engineer is "A man who does the mostest with the leastest." To the industry, to our members and friends, and even to our enemies, I pledge, with complete confidence, that our Association will continue, as engineers, to do the "mostest" to meet the challenges of the times to our industry and our country.

I. N. TULL

President, AISE

JOHN L. YOUNG
First Vice President

E. L. ANDERSON
Second Vice President

JOHN H. VOHR
Treasurer

NEWLY ELECTED OFFICERS AND DIRECTORS

JOHN L. YOUNG, a native of Evansville, Ind., graduated from University of Indiana. Mr. Young began his career with Timken Roller Bearing Co. in Canton, Ohio, where he held various positions in the alloy tube and steel departments; he later transferred to the metallurgical department. In 1930, Mr. Young went to Pittsburgh for Timken as a development engineer, and later returned to Canton and became assistant general manager of Timken's industrial division. Mr. Young joined United Engineering and Foundry Co., Pittsburgh, Pa., in 1936. In 1941, he was loaned as project manager to design and construct the Defense Plant Corp.'s aluminum rolling mills at Trentwood, Wash. He was next vice president in charge of industrial research and development for United Engineering and Foundry Co. He then moved to National Tube Co. in 1945 as vice president in charge of engineering. On January 1, 1951, he became vice president–chief engineer of the United States Steel Co. in Pittsburgh.

E. L. ANDERSON has been associated with the iron and steel industry for over 30 years, having started in the electrical department of the Bethlehem Steel Co. at Sparrows Point, Md., in 1917. He was transferred to the Johnstown plant of Bethlehem in 1937, and was appointed superintendent of the electrical department of that plant in 1940.

J. H. VOHR was graduated from Cornell University in mechanical and electrical engineering in 1916 and became associated with the New York State Railways as an electrical engineer. After serving in World War I, he joined the American Sheet and Tin Plate Co. at Farrell, Pa., and later was transferred as assistant superintendent of strip mills to the company's plant at Gary. After leaving the company in 1931, he was engaged with the installation and operation of the wide strip mills of the Inland Steel Co. and Youngstown Sheet and Tube Co. In 1936 he joined the Granite City Steel Co., Granite City, Ill. as superintendent of the hot and cold strip mills and was promoted in 1937 to general superintendent of plants. In 1942 he transferred to the Carnegie-Illinois Steel Corp., being stationed at the general offices in Pittsburgh until his appointment in 1943 as assistant general superintendent of South Works of Chicago, Ill. In 1949, he was promoted to the general superintendency of Gary, Ind. steel works.

W. H. COLLISON was graduated from the University of Cincinnati in 1926 with a degree of chemical engineer. This was a cooperative course during which he worked in the coke plant of Pittsburgh Crucible Steel Co., beginning in 1924 and continuing after graduation until 1927. He then went to the Central Alloy Steel Corp., Massillon, Ohio, as heater in the coke plant, and was made turn foreman shortly thereafter. In 1935, Mr. Collison went with the Pure Oil Co., Marcus Hook, Pa., as a chemist. Following this he came to Detroit as boss heater for the new coke plant of Great Lakes Steel Corp., being subsequently promoted to assistant superintendent and later to superintendent of the coke plant. In 1951 he was made assistant general superintendent, blast furnace division.

JAMES D. O'ROARK was born in Broadway, Va., and received grade and high school education in Covington, Ohio. He graduated from Ohio State University in 1926 with a degree in electrical engineering. After graduation he was employed in student engineer training course and test floor from 1926–1930 at Westinghouse Electric Corp.'s East Pittsburgh works. He has been employed by Weirton Steel Co. from 1931 to present date as electrical field engineer, electrical foreman of strip steel and sheet mill dept., assistant electrical superintendent, electrical superintendent and assistant to manager of service and maintenance department, which last position he now holds.

B. C. BLAKE was born in Lexington, Ky. He attended Washington & Lee University and then transferred to Alabama Polytechnic Institute where he received his degree in civil engineering. He began work with Connors Steel Co. in May, 1929, as a detailer in the structural engineering department. He later advanced through the following jobs: assistant fabricating shop foreman, mill foreman, plant engineer, chief engineer, assistant works manager and works manager. In November 1950 he was also made vice president.

W. H. COLLISON
Secretary

JAMES D. O'ROARK
Director-at-Large

B. C. BLAKE
Director

A. K. BLOUGH
Director

R. W. COUCH
Director

A. G. ERICSON
Director

ASSOCIATION OF IRON AND STEEL ENGINEERS 1952

A. K. BLOUGH graduated from the U. S. Naval Academy, and was employed by Bethlehem Steel Corp., in the Johnstown open hearth department from 1924–1934. He then went to work for Republic Steel Corp. in general metallurgical from 1934–1936. He worked in plant metallurgical–Central Alloy from 1936–1940. He has worked on open hearth and electric furnaces from 1940–to date. He is now superintendent No. 2 and No. 3 melt shops, Canton Steel Works, Republic Steel Corp., Central District.

D. N. EVANS is a native of Wisconsin and attended Marquette University, Clemson College, University of Wisconsin. He received a degree in the mechanical engineering from the University of Oklahoma in 1935. Since that time he was employed by the Inland Steel Co., East Chicago, Ind., in the following positions: maintenance department of 40-in. blooming mill, machine shop foreman, mechanical turn foreman, hot strip mill, lubrication engineer, and is at present assistant general master mechanic.

ROBERT W. COUCH was born at Independence, Va., and later moved to Roanoke where he graduated from Jefferson High School. In 1928 he received a B.S. degree in Electrical Engineering from Virginia Polytechnic Institute. He entered the loop training course of the Bethlehem Steel Co. at Bethlehem, Pa. in June of the same year. From 1928 to 1936 he served successively as draftsman, repairman, motor inspector, wireman, sub-station operator and experimental engineer. In 1936 he was made assistant general maintenance foreman of the structural mills in Saucon Division. In 1939 he became general electrical foreman of Saucon Division, and in 1941 assistant superintendent maintenance. In 1948 he was appointed superintendent of electrical and mechanical maintenance in the Saucon Division of the Bethlehem plant. He is now superintendent of Saucon Mills and shipping yards, Saucon division.

R. W. GRAHAM has been employed in the steel industry since 1916, except for 18 months spent in naval service in World War I, as radio and communication officer on U.S.S. Arizona. Starting with Lackawanna Steel Co. as assistant electrical engineer, he remained in that capacity until the Lackawanna plant was absorbed by Bethlehem Steel Co. in 1923. He then worked as assistant superintendent of the electrical department until April, 1943, when he was made general electrical superintendent, which position he now holds. He is a graduate of North Dakota and Cornell Universities and taught in Cornell Engineering College for three years.

A. G. ERICSON was graduated from School of Mines, Filipstad, Sweden in 1916. He arrived in the United States in 1920. He started work with the Carnegie Steel Co. at Homestead steel works in 1924 and successively progressed as mechanical draftsman, engineer, assistant to the chief engineer, assistant chief engineer, and in 1938 was appointed chief engineer for the Homestead district works of Carnegie-Illinois Steel Corp.

EDGAR A. HAWK was born in Johnstown, Pa., and attended grade school and high school in Elyria, Ohio. He graduated from Penn State with a B.S. degree in Metallurgy in 1918. After graduation, he attended Officers Training School at Fort Monroe, Va., and received a commission in the Coast Artillery. During the latter part of 1918, he entered the chemistry department of the National Tube Co., Lorain, Ohio. In 1919, he entered the experimental engineering department, Carnegie Steel Co., Duquesne, Pa. After a year at Duquesne, he joined the Tennessee Coal, Iron and Railroad Co. where he now works as fuel engineer.

D. N. EVANS
Director

R. W. GRAHAM
Director

E. A. HAWK
Director

JAMES J. HEALY
Director

R. W. HOLMAN
Director

J. N. IMEL
Director

JAMES J. HEALY was born in Bridgeport, Conn., where he received his elementary schooling. He graduated as a mechanical engineer from Drexel Institute. He served in the army in France in World War I. From 1922 to 1934, he worked as draftsman and engineer with U.G.I. Contracting Co., later merged into United Engineers & Constructors, Philadelphia, Pa. He started as mechanical engineer with Armco in 1934, later advanced to senior mechanical engineer, and in 1945 to present position as project engineer.

R. W. HOLMAN was born in Chicago, Ill. July 24, 1911 and moved with his family to Gary, Ind. one year later. After completing high school in Gary, he worked two years as a finish catcher in the Gary Tin hot mills of the American Sheet and Tin Plate Co. prior to entering Purdue University. He was graduated from Purdue in 1935 with a B.S. degree in electrical engineering. After graduation he started as electrician's helper at Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp. In early 1938 he advanced to power foreman, and during 1940 was appointed assistant to superintendent electrical maintenance. During 1946 he was appointed general supervisor electrical engineer and in May 1950 advanced to assistant works chief engineer. He is now chief engineer, Sheet and Tin Mills, United States Steel Co., Gary, Ind.

JAMES N. IMEL was born at Cambridge Springs, Pa., in the year 1907. He received his elementary and high school education in Cleveland, Ohio and graduated from Bethany College, Bethany, W. Va., in June, 1930. He started to work with the Jones & Laughlin Steel Corp. shortly after his graduation as a student trainee. After holding various jobs in the rolling mills department, he was advanced to the position of general foreman, D.S. Mills in 1937. In April, 1946, he was promoted to the position of assistant superintendent of rolling mills and, on August 1, 1947, was appointed superintendent of rolling mills, Pittsburgh works. He is now superintendent, continuous strip and sheet dept., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

LEONARD LARSON was employed as draftsman at Jones & Laughlin Steel Corp. and Carnegie Steel Co. in Pittsburgh, Pa. from 1913 to 1917, while attending night school at Carnegie Tech. He moved to Massillon in 1917 as draftsman for Central Steel Co., was appointed chief draftsman in 1918 and assistant chief engineer about 1923. He was appointed assistant chief engineer for Central Alloy Steel Corp., in 1926 in merger between Central Steel Co. and United Alloy Steel Corp., and was appointed chief engineer in 1929. He served in this capacity for Central Alloy Steel Corp., and Republic Steel Corp., after merger in 1930, until 1939, when he was transferred to Cleveland District as district chief engineer which position he now holds. During period from 1933 to 1936, he spent about one year on special open hearth work for the corporation, and about two years in the operating department as divisional superintendent at the Massillon Steel plant.

W. J. REILLY was born in Youngstown, Ohio, where he attended grade school and high school. He graduated from University of Michigan in chemical and metallurgical engineering, and started work at Youngstown Sheet and Tube in the metallurgical department in 1926. He served in various capacities in the metallurgical department, fuel department, bessemer and open hearth departments. He was appointed superintendent of the open hearth in 1943. He left Youngstown Sheet and Tube Co. to go to the Ford Motor Co. in April 1946 as assistant superintendent of steel operations. He was appointed manager of steel mills in 1949.

WILBUR G. SMITH entered Rensselaer Polytechnic Institute in 1930, and received a B.S.M.E. in 1934. That same year he started with the Bethlehem Steel Co., Lackawanna, N. Y., as millwright in the bar mills. He was then advanced to a turn foreman in the 54-in. blooming mill and 48-in. structural mills. After a short period of time, he became assistant general foreman in the billet preparation department. The next move was to assistant superintendent of the 54 and 48-in. mills. In August of 1948, he became superintendent of the 54 and 44-in. blooming mills, 32-in. rail mill, and the splice bar and tie plate shop. His present position is assistant superintendent of the strip mill, which change took place August 1950.

LEONARD LARSON
Director

WILLIAM J. REILLY
Director

W. G. SMITH
Director

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1949 C. H. WILLIAMS, *Chief Engineer, Manufacturing Division*, United States Steel Co., Pittsburgh, Pa.

1950 A. S. GLOSSBRENNER, *Vice President Operations*, Youngstown Sheet & Tube Co., Youngstown, Ohio.

1951 JOHN F. BLACK, *Manager, Continuous Casting Section*, Freyn Engineering Division, Koppers Co., Inc., Chicago, Ill.

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LUBRICATION ENGINEERING DIVISION

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C. E. PRITCHARD, *Superintendent of Finishing Mills*, Alan Wood Steel Co., Conshohocken, Pa.
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LEONARD LARSON, *Chief Engineer*, Republic Steel Corp., Corrigan-McKinney Plant, Cleveland, Ohio.

Developments

IN THE IRON AND STEEL INDUSTRY

During 1951

By I. E. MADSEN

▲ THE second half of the twentieth century opened with a year of records for the steel industry. The pressure for more steel and more production, intensified by the imposition of wartime demands on peacetime requirements, in 1951 resulted not only in record production of steel, iron and finished products, but also in record additions to plant capacity.

Total steel production in 1951 was about 105,200,000 tons or 101.0 per cent of capacity, compared with 96,836,075 tons in 1950. Of this, estimated figures give a production of about 93,300,000 tons for the open hearth, 4,850,000 tons for bessemer and 7,050,000 tons in the electric furnace. Total pig iron production in 1951 was estimated at 71,400,000 net tons or 99 per cent of capacity, compared with 64,810,272 tons in 1950.

In spite of peak production during the year, steel company earnings in 1951 lagged behind corresponding periods in 1950, as higher costs and taxes cut down net earnings. Recent increases in Federal income tax result in taxes as much as 100 per cent higher than the previous year. These 1951 increases are on top of the 83 per cent increase in 1950 over 1949. Compared with 1940, taxes in 1950 were 300 per cent higher.

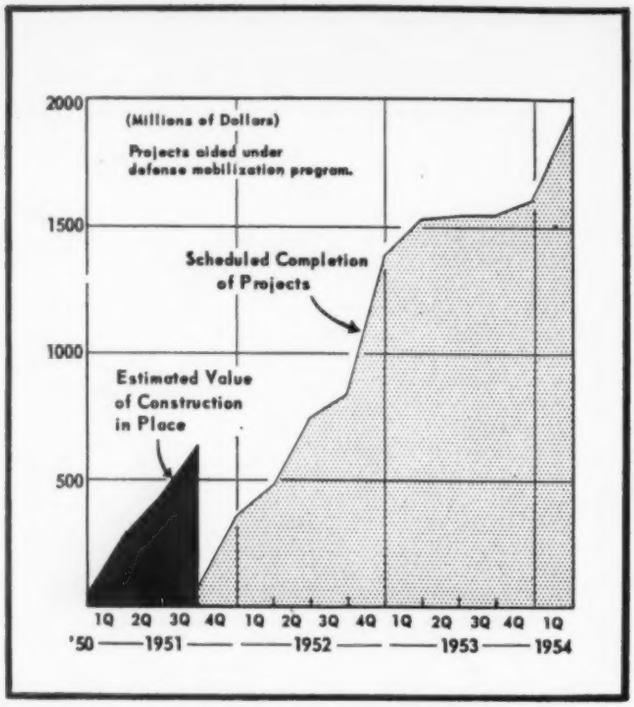
Future prospects for earnings will be seriously affected by the demands which the CIO steel workers raised at the end of 1951. In addition to larger fringe benefits and higher wages, the steel workers raised a new issue, the guaranteed annual wage. Although this may have little effect under present peak operations, it will have a very serious effect on future operations when plants may be producing at rates far below capacity. In addition to the proposed increases, labor costs were up in 1951, hourly payments during the first nine months averaging $1.939 or 21.9 cents higher than in the similar 1950 period.

An item which may affect future pattern of steel expansion is the demand brought up by the union at the end of the year to eliminate geographical differentials in wage rates. At the present time there is about an 11¢ gap between the North and the South.

The War Stabilization Board approved an incentive pay plan at Jones & Laughlin Steel Corp. which may have an effect on production. Under this new plan, each machine is rated according to a practical production capacity upon which both the union and the company agree. After equipment has been rated for average conditions, if the operator obtains more production from it than the rated capacity he gets a bonus. The worker's pay thus rises in the same proportion as the increase in productivity.

Low profits have given rise to one of the problems in steel expansion, that of obtaining the finances for the additional expansion which has been required. In 1949 the companies which represent 92 per cent of the ingot capacity earned $514,000,000 or 7.1 per cent on sales. This was also equivalent to 9.5 per cent on an investment of $5,400,000,000. In 1950 the proportions were about 50 per cent better. These earnings are high for steel, but low for industry in general. On the average the steel industry has probably not earned more than 3 per cent on their invested capital, and this low rate of return makes steel relatively unattractive for investment groups. As a result, a large proportion of expansion is being paid for out of accumulated earnings. Stock flotations are a poor source, as present prices on stock per ton of capacity vary from low of about $40 to a high of about $100. Since new capacity costs about $300 per ton of capacity, there is little likelihood of raising capital through stock flotations. It is for this reason that so much of the existing expansion

The steel industry worked night and day in an effort to meet demands.


2000
(Millions of Dollars)
Projects aided under defense mobilization program.
1500
Scheduled Completion of Projects
1000
Estimated Value of Construction in Place
500
1Q 2Q 3Q 4Q 1Q 2Q 3Q 4Q 1Q 2Q 3Q 4Q 1Q
'50 —1951— —1952— —1953— 1954

The steel plant expansion program is about one-third complete.

has been financed through accelerated tax amortization, which enables firms to capitalize cash income.

Obtaining additional expansion through improving or rounding out existing facilities is much cheaper and quicker. An average for this cost may be less than $100 per ton of additional capacity thus obtained. To make integrated expansion attractive, steel prices must be raised over their present level. One estimate made by a steel company president is that steel prices should be increased at least $15 a ton.

A decision was reached on pricing. The Federal Trade Commission and steel producers reached a settlement in which the steel companies agreed to avoid any planned common courses of action in arriving at prices for steel products. The order from the FTC does not include any concessions on the part of the steel industry as to the truth of any FTC findings or charges. The companies are allowed to use delivered prices or freight absorption when innocently and independently pursued with the object and result of promoting competition.

Steelmaking costs have been definitely affected by changes in freight rates. Freight rates were raised 9 per cent on eastern roads and 6 per cent elsewhere last summer. These rates included a 6 per cent increase on iron ore, hard and soft coal, and coke. As a result, freight rates on iron ore have gone up 38 per cent since June 30, 1946, and rates on iron and steel products have gone up 78 per cent. One proposal being considered calls for uniform classification and uniform rates for some types of freight everywhere east of the Rockies. Commodity rates will not be affected by the proposed orders.

As a result of higher freight rates, river rates are attracting industry business. More plants are considering river locations and more river equipment is being put into service. As an example, the river rate from Pittsburgh to Evansville, Ind. is under $3.00 a ton, whereas rail rate is over $12.00 a ton and delivery time in days by barge is not quite twice rail time.

Up to the present time there have been no bad snags due to lack of transportation equipment. However, as defense production goes up there may be such snags if maximum utilization has not been made of all equipment.

As an example of how transportation has shifted in 1950, the railways accounted for about 60 per cent of ton-miles; motor trucks, 11 per cent; Great Lakes, 11.6 per cent; inland waterways, 4.5 per cent; and pipe lines, 13.5 per cent. This is a drop of about 3 per cent for the railroads, an increase of 3.2 per cent for motor trucks, a decrease of 2.5 per cent for Great Lakes, an increase of 0.8 per cent for inland waterways and an increase of 1.4 per cent for pipe lines between 1939 and 1950.

Although it appears that the demand for steel is continuing at a high level, there is a very definite softening in demand as indicated by grey and black market prices. These have dropped very markedly and premiums for some items have disappeared.

The steel distribution pattern has been affected by the defense program. The automotive market has declined in importance, and tonnage produced for freight car manufacturers, ordnance and other military users have become relatively more important.

The expansion and improvement program has also affected the product mix. Data published by the American Iron and Steel Institute shows the following changes in capacity from 1948 to 1951. (See Table I).

TABLE I

CAPACITY CHANGES SINCE 1948

Rolled Products	Capacity — Net tons	
	1948	1951
Hot-rolled sheet, strip*	26,589,460	34,492,310
Cold-rolled sheet, strip	11,413,785	14,324,170
Pipe, tubing	8,778,720	12,576,170
Heavy structural shapes, piling	5,484,330	6,137,450
Plates	7,865,700	8,260,580
Tin, terne, plate**	5,890,250	6,453,340
Hot-rolled bars***	12,008,260	11,977,810
Wire rods	6,195,170	6,360,350

*Includes strip for cold-reduced black plate and tin plate.
**Electrolytic and hot-dipped.
***Not including concrete reinforcing bars.
Note: This table does not cover all steel products.

These changes reflect the demands of the automotive and petroleum industries.

The AISI estimates that, barring all-out war, direct military and atomic energy requirements for steel will reach an annual maximum of 12,000,000 tons of steel by the middle of 1952. Shipments of finished steel in 1951 are expected to exceed 80,000,000 tons. Civilian industry has been fairly well taken care of as indicated by the fact that all major consuming industries except automotive and appliances received more steel during the first seven months of 1951 than in the same period of 1950.

The large amount of steel available for other than military uses is one of the factors behind the criticisms of the steel industry on control. The industry has been

building up a strong case for decontrol, claiming that controls are more harmful than helpful. In addition, its production is stated to be enough to maintain the industries which use steel. It is believed, for example, that much of the demand is artificial and is due primarily to duplication in orders to be sure that users get on someone's order schedule.

It is expected that the peak demand for steel for defense uses will be reached by the middle of 1952. This peak should hold for a few months and then gradually recede. This estimate could change very quickly, however, if the defense program is expanded.

One item of production which has been in very great demand is structural steel. Structural demand for the first quarter of 1952 is 205 per cent of available supply, based on requests on the DPA. The shortage of structural steel was demonstrated when the structural steel allotment required for the steel expansion program was cut to 51 per cent during the latter part of 1951. Although allotments for structural steel were very markedly cut, the government still put the pressure on the industry to continue with their expansion program, and in addition demanded that the program be accelerated.

It is estimated by the AISI, however, that after steel requirements for direct military use and atomic energy are supplied in 1951 and 1952, there will be as much finished steel available for other usage as this country consumed in 1950.

Although much steel is available for what is called civilian industry, the NPA classifies much industry as being "defense supporting." In this classification are included industries such as petroleum, transportation, electric power, industrial machinery, etc., and in the third quarter of 1951 alone the NPA estimated that steel requirements for this classification totaled about 15,660,000 tons.

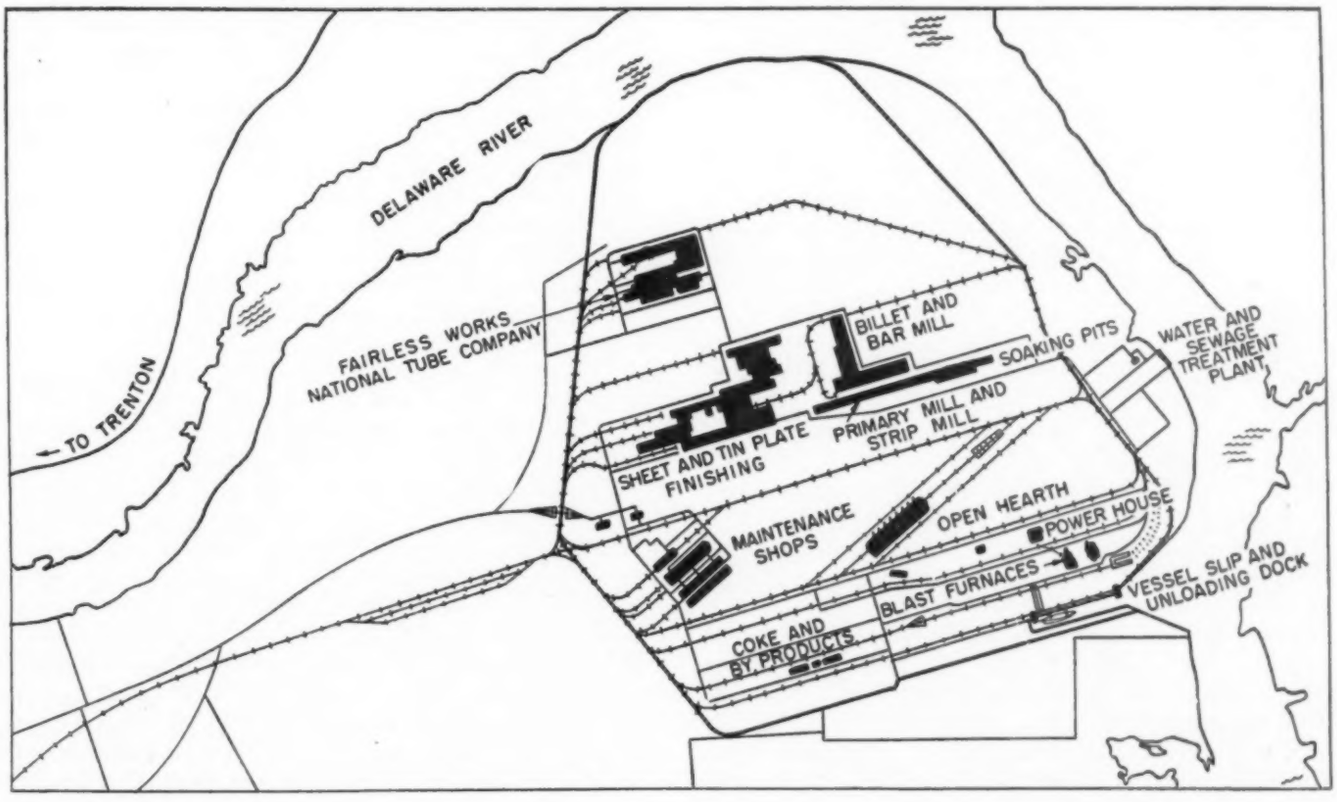
As of January 1, 1951, pig iron and ferroalloy capacity of 250 furnaces officially totaled 72,471,780 net tons; total coke capacity was 72,488,200 by-product and 11,571,500 beehive net tons, steel industry coke capacity totaled 62,569,890 by-product and 3,690,750 beehive, steel capacity totaled 104,229,650 net tons and finished hot rolled products capacity totaled 83,699,890 net tons. The industry consisted of 253 companies with 375 plants in 31 states. All of these capacities are new peaks in the industry's history.

Steel capacity at the end of 1951 was estimated at 109,000,000 tons. It is also estimated that the steel capacity will be 117,000,000 tons and blast furnace capacity will be 79,300,000 tons by the end of 1952.

At the end of the year the DPA set up a production and expansion goal which calls for an output of 120,000,000 ingot tons of steel by the beginning of 1954 or the end of 1953. DPA also stated that enough tax amortization certificates had been issued to meet this needed expansion and that no more will be issued. This apparently is the end of the program. Tax amortization certificates have been issued for about 23,000,000 tons, which, added to existing capacity should be sufficient to maintain a sustained level of 120,000,000 tons per year.

The expansion goal for blast furnaces is set at 85,000,000 tons for the beginning of 1954. This figure does not include ferroalloy capacity, but does include capacity for pig iron and castings. This figure will be adequate, however, only if present ratio of scrap to pig iron can

The Fairless Works is the largest single expansion under way at the present time. It is about 35 per cent complete.



be maintained. If scrap becomes insufficient, more blast furnace capacity will be needed.

The program for by-product coke ovens is set at 84,000,000 net tons by the end of 1953. This will be sufficient to supply coke necessary for making pig iron, ferroalloys, castings and other industrial and household uses. It is expected that beehive oven production will produce from 7,000,000 to 8,000,000 tons annually at that time.

According to the American Iron and Steel Institute, steelmaking capacity in districts will be as given in Table II.

TABLE II

EXPANSION BY DISTRICTS

District	Capacity January 1951	Per cent of total	Capacity 1953	Per cent of total
Pittsburgh-Youngstown	41,400,000	39.7	45,000,000	38.2
Chicago	21,500,000	20.7	23,900,000	20.3
Eastern	20,800,000	20.0	24,200,000	20.5
Cleveland-Detroit	9,600,000	9.2	12,000,000	10.2
Western	5,900,000	5.7	6,700,000	5.7
Southern	4,900,000	4.7	6,000,000	5.1
Total	104,200,000	100.0	118,000,000	100.0

Note: Totals do not add up exactly because of rounding off of numbers.

The tremendous expansion program is reflected in the capital required; 1951 sets a new record with about $1,200,000,000 being spent for expansion and improvements. This outlay is about double that in 1950.

The Defense Production Administration estimates that at the end of the third quarter of 1951 about $631,000,000 of new steel plant equipment, being built under the tax benefit program, was in place. This is about 35 per cent of the work scheduled under accelerated tax depreciation. About 19 per cent of the more urgently needed blast furnace capacity is in place. The lag of blast furnace capacity is one of the factors which make scrap such an important requirement for maintenance of steel production. Although 35 per cent of the dollar value of the steel program is in place, this does not mean that this percentage is in production. Almost $2,000,000,000 worth of steel plant facilities are receiving tax aid.

A method of financing steel expansion shows a trend which may become more important in the future. As an example of this, Chrysler Corp. and Packard Motor Car Co. are loaning Pittsburgh Steel Co. $10,000,000 under two agreements by which the Pittsburgh Steel Co. will ship the two automobile manufacturers 1,000,000 tons of steel over a five-year period. This agreement is similar to those between General Motors Corp. and Jones & Laughlin Steel Corp., and between General Motors and Republic Steel Corp. In this way the automobile manufacturers are staying out of the steel manufacturing business but are loaning money for additional facilities which may be returned to them in the form of materials.

In spite of the additional capacity which has gone into production the United States is starting to import steel products. Imports in 1951 rose to an annual rate of about 2,500,000 tons. The NPA estimated that about 20 per cent of steel rod used in wire mills came from abroad, and about 12 per cent of steel plate used by the small independent fabricators came from European steelmakers.

Based on January 1, 1951 figures, the new geographic center for steelmaking capacity in the United States is about one mile north of Mt. Cory, Ohio. This is a move of about 13 miles northwest of the previous center computed back in 1945. The shift has been aided by large increases in steel capacity on the Pacific Coast. However, the next move will probably be to the East when the Fairless plant goes into operation in eastern Pennsylvania.

Although expansion of new facilities had been a spectacular item in the news, perhaps of more importance is the expansion of existing facilities and improvements in old plant. Blast furnaces being renovated are often being built larger. Open hearths are rebuilt for larger capacity. Such changes in old facilities have resulted in additional capacity much more quickly than would have been possible through the building of new facilities.

Additional capacity is obtained through what may appear to be very minor ways. Standardization of operating procedures has had a tendency to increase capacity by obtaining greater production from existing facilities. One method of doing this is to improve materials handling layouts to speed flow of materials. In some plants the washing and blending of coal and increased use of beneficiated or sintered ore improves production. In the open hearth, in addition to enlarging furnaces, additional production is obtained through quicker methods of repair which reduce outage time. Better preparation of scrap and the use of oxygen have also increased production. In addition, speeding up mills has in some cases increased blooming mill capacity 25 per cent, and new motors and controls on continuous sheet and plate mills have increased productivity to 40 per cent.

An example of the cost of new steel capacity is that the program since 1946 is costing about $5,000,000,000 and this is adding only 26,000,000 tons of steel capacity. In contrast at the beginning of 1946 when steel capacity was 92,000,000 tons, the total investment was $5,800,000,000. Another way of looking at the cost of additional steel plant capacity is that it now takes an investment of about $90,000 to create a new job in a plant.

DETAILED EXPANSION PROGRAM

The expansion in the steel industry has also brought a number of newcomers to the business. One newcomer which has actually started construction of a new plant is the Green River Steel Co. which is building a small electric furnace plant near Owensburg, Ky. Another plant which tried to receive authorization was Gibralter Steel Co. which was to build a 1,600,000 ton plant at Trenton, Mich. This however fell through. There were a number of others, but none of these have materialized up to the present time, and are not likely to do so.

Quickly reaching completion is the new open hearth furnace expansion of the Jones & Laughlin Steel Corp. on the west bank of the Monongahela River. Plant will be in full operation in 1952.

The Tennessee Steel Corp. was incorporated to build an electric furnace plant at Oneida, Tenn. This plant was to consist of two 25-ton, top-charge electric furnaces. Another plant was the Yolo Iron and Metal Co. which was incorporated in Nevada. This company proposed to build a plant in central California at a cost of about $264,000,000, capable of turning out 1,000,000 tons of steel annually. Very little was known about the details of this project, and one of the questions was where the raw materials for the plant would come from.

The New England Steel plant location was tentatively set at New London, Conn., thus giving it an ocean-side location. However, adverse reports have held up the project up to the present time, although the company has been able to obtain extensions on the certificate of necessity so that the project is not completely abandoned.

Another new ambitious project was the North American Steel Co. which wished to borrow money to erect a mill with an annual capacity of 1,250,000 tons at Camanche, Iowa.

Another plant was proposed which was to be located on the James River in southeastern Virginia.

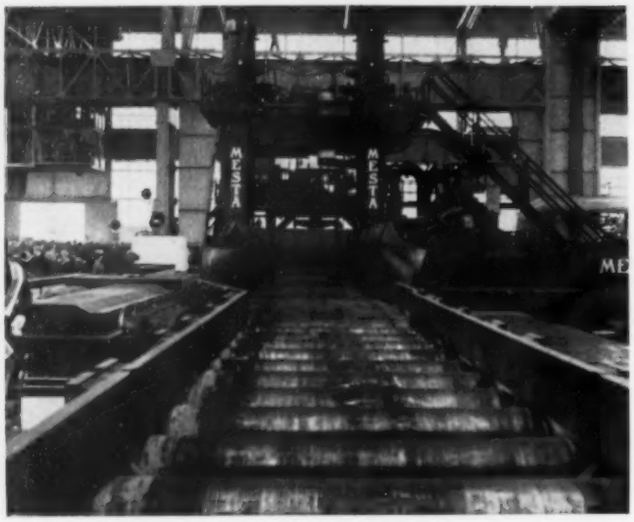
The major part of the expansion program is being executed by the established firms. The expansion program at United States Steel Corp. alone between January 1, 1951 and the end of 1952 will add approximately 2,500,000 tons of steel capacity in addition to the 33,900,000 tons in operation January, 1951. The largest single unit of expansion on this program is the Fairless Works located at Morrisville, Pa. This plant has now finalized to where it will have an annual ingot capacity of 1,800,000 tons. In addition, finishing facilities are provided for a wide range of products for both defense and civilian needs including hot and cold rolled sheets and strip, tin plate, bars and pipe. Some production should be coming from this plant very shortly.

The expansion program of U. S. Steel alone left to be completed as of January 1, 1951 totaled $742,000,000, including the Fairless Works at Morrisville, Pa. At the Fairless Works, two 28-ft diam, 1650-ton per day, blast furnaces are under construction. These furnaces will get coke from two batteries of 87 ovens each. Nine 275-ton stationary basic open hearths are in the initial phase of construction. The plant will have ten batteries of two pit furnaces. Unusually fast and powerful rolling mills are being installed as reported in the Rolling Mill section of this article. Eleven 4-stack batch annealing furnaces with 27 bases will be used to anneal sheet and tinplate specialties. This plant is about 35 per cent physically completed. The first battery of coke ovens and one blast furnace will be ready for operation in the second quarter of 1952, and initial production of steel ingots will also take place in that quarter. It is hoped that full capacity of 1,800,000 tons of ingots per year will be reached in the third quarter of 1952.

National Tube Co. facilities at Morrisville will include two continuous butt weld mills, a skelp mill, a pipe mill, pipe finishing facilities and a warehouse.

When the expansion program of Columbia Steel is completed at its Pittsburg plant, it will have a processing capacity of 350,000 tons of tin plate and 192,000 tons of steel sheet. This compares with present annual capacity of 200,000 tons of tin plate and 125,000 tons of steel sheet. A new continuous galvanizing line is being installed at this plant. A second 4-stand cold rolling mill was installed which will be devoted entirely to cold rolling of sheets leaving a present 56-in., 5-stand mill which handles both tin plate and sheet available for handling tin plate alone.

In the Pittsburgh and Chicago districts, United States Steel Co.'s improvements and additions to equipment have added 1,660,000 tons to the company's annual ingot capacity. In addition, 200,000 tons of cold rolled steel capacity and 120,000 tons of tin plate capacity, were added to Gary Sheet & Tin Mill. At the Homestead Works, 375,640 tons were added to slabbing capacity and at the South Chicago Works 108,000 tons of wide



European steel expansion was expedited with ECA American aid. Mill shown was put into operation at the United Iron and Steel plant in Linz, Austria.

flange beam capacity is practically complete. The South Works is also adding 151,500 tons of additional slab capacity.

At the Geneva Steel Co. plant, the building of an additional open hearth furnace as well as auxiliaries will add 160,000 tons to its capacity. Additional hot rolled sheet facilities at this plant will add 234,750 tons.

Tennessee Coal, Iron & Railroad Co. is planning to expand its steelmaking capacity 500,000 tons annually by the first quarter of 1953. In addition, a third continuous galvanizing line is being installed at the sheet mill. New sheet facilities will be in operation by the third quarter of 1953.

Another development in United States Steel Corp. is the consolidation of a number of the old operating companies into divisions of United States Steel Co. Effective January 1, 1952, the following major companies of United States Steel including American Steel and Wire Co., National Tube Co., Tennessee Coal, Iron and Railroad Co., Geneva Steel Co., Columbia Steel Co., have become operating divisions of the United States Steel Co. In addition, other subsidiaries such as American Bridge Co., Oliver Iron Mining Co., Consolidated Western Steel Corp., Virginia Bridge Co., Pittsburgh Steamship Co. and several others have all become divisions. In some cases several companies were combined together to form one operating division such as The American Bridge Co. and Virginia Bridge Co. became the American Bridge Division. The Columbia Steel Co. and the Geneva Steel Co. have also been combined into the Columbia Geneva Steel Division of the United States Steel Co. A more streamlined organization with closer operating control should result from these mergers.

Bethlehem Steel Co. is embarked on a $300,000,000 expansion program. This program will add 1,600,000 tons of ingots to Bethlehem's capacity in addition to that which was in existence on January 1, 1951. They will be in operation at the end of 1952. Bethlehem had also added 1,000,000 tons during the year 1950. The biggest addition is at Bethlehem's Lackawanna plant, where 1,080,000 net tons are being added. Sparrows Point is getting 740,000 net tons, Steelton 352,000 net tons, Bethlehem 188,000 net tons, Johnstown 180,000 tons and Los Angeles 60,000 tons. Lackawanna is getting a new blast furnace and a battery of 76 new coke ovens. Sparrows Point is getting a battery of 65 new coke ovens. Two 77-oven batteries which were authorized for Johnstown last year are under construction.

Republic Steel Corp. is on a five year capital expansion program which is estimated at $250,000,000 for open hearths, blast furnaces, and coke ovens. By 1953 Republic will have a capacity of more than 10,000,000 tons. The amount of expansion is about 1,174,000 tons, of which 675,000 tons is at Cleveland.

One of the steel expansion programs farthest along is that undertaken by the Jones & Laughlin Steel Corp. This company started in November to produce steel from one furnace of its new, eleven 250-ton furnace open hearth plant at the Pittsburgh Works. The balance of the furnaces will be in operation before the end of 1952, giving an annual capacity of 2,000,000 tons. The program also includes a new blooming mill and bar mill which will go into operation in 1952. At the Aliquippa Works, Jones & Laughlin is installing a new electrolytic tinning line, and a new rod mill. A battery of 59 by-product coke ovens went into operation in March, 1951. The company is enlarging a blast furnace at the Otis Works in Cleveland, Ohio, and adding two additional open hearth furnaces at this plant. Extensive work was also done on the ore dock and ore handling facilities. The program of J & L in 1951 and 1952 is estimated to cost $200,000,000, and the expansion program will increase ingot capacity 1,560,000 tons, or 32 per cent, by 1952.

The Youngstown Sheet and Tube Co.'s expansion program will provide facilities for an additional 1,000,000 tons of ingots and will cost about $100,000,000. At the present time, the Youngstown district of the company makes about 66 per cent of the company's steel. With the present expansion program under way, capacity will be split about 50-50 between the Youngstown and Chicago districts.

Weirton Steel Co.'s ingot capacity is being increased 20 per cent. When completed Weirton will have a new capacity of 2,400,000 tons annually. The construction program of National Steel at both Weirton and Detroit at the start of 1951 totaled $150,000,000 and will increase capacity by early 1953 to 6,000,000 tons. In addition, National Steel has estimated that the proposed $500,000,000 steel plant at Paulsboro, N. J. with an annual capacity of 1,750,000 tons will cost $291 per ton of capacity compared with $112 in 1936. The decision on construction is now at least no closer than one year away, although land has been purchased.

Wheeling Steel Corp. has a $24,000,000 construction program under way which includes a 63-oven coke battery, giving Wheeling a total of 314 ovens. In its most recent plans, Wheeling will modernize its cold reduced sheet facilities, recondition two bessemer converters, and provide additional annealing capacity at Steubenville. A new $2,500,000 continuous galvanizing line will be installed at Martins Ferry. By 1953 Wheeling Steel will increase annual coke capacity by 365,000 tons to 1,661,000 tons, pig iron by 121,500 tons to 1,800,000 tons, and ingot capacity by 150,000 tons to 2,010,000 tons compared with July 1951.

Pittsburgh Steel Co. is getting into the finished steel

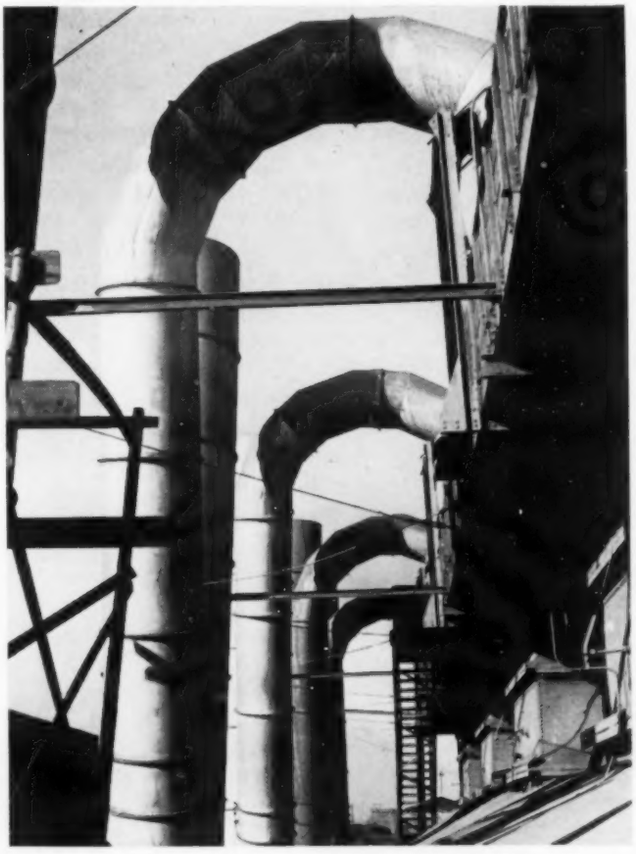
business in its expansion program. It expects that its product mix will be so changed that over half the production will be in flat rolled products. The company recently purchased control of Thomas Steel Co., a producer of various specialty strip steels. This put Pittsburgh Steel Co. into the flat rolled business approximately one year ahead of the schedule based on its new 66-in. sheet and strip mill. Pittsburgh Steel's expansion program will increase open hearth capacity in Monessen, Pa., by 500,000 tons. Estimated cost is $56,000,000.

Sharon Steel Corp.'s plans for expanding and modernizing its mill at Farrell, Pa. is estimated to cost $50,000,000. A new blast furnace is being added and the open hearth furnaces will be replaced by larger units. A new blooming mill is also scheduled.

The Allegheny-Ludlum Steel Corp. has completed a three-year $30,000,000 expansion program, and is starting another three-year $30,000,000 program. Of this, $25,000,000 will be spent at the Brackenridge and West Leechburg plants to expand facilities for finishing high-alloy steel products. The program includes expansion of flat rolled facilities by installation of new hot and cold strip and sheet mills.

Crucible Steel Co.'s $27,250,000 expansion program includes enlargement of four electric furnaces which will increase capacity for electric steel about 37 per cent. A new combination bar mill consisting of a roughing stand and four stands of finishing mills is also to be installed. Crucible Steel is adding 29 additional coke ovens to the present 184-oven plant. The new blast furnace will have a 25-ft hearth diameter and will be rated at 30,000 tons per month. The open hearth furnaces are being increased in capacity from 134 to 165 net tons per heat. The four electric furnaces which are being rebuilt are having their shell diameter increased so that their rating will go from 45 to 75 tons each. Major portion of new construction is at the Midland plant.

At the Donawitz plant, ore requires roasting before use in blast furnace. After processing, ore is comparable to the best in the world because of low phosphorous and sulphur content.



The Ford Motor Co. is spending $43,000,000 to add 190,000 tons of finished steel capacity. This includes additional coke oven and other facilities.

McLouth Steel has a large expansion program estimated to cost $96,600,000 at Trenton, Mich. The major item in this program is a new blast furnace. Ingot capacity and strip steel finishing facilities will be expanded and improved.

Barium Steel Corp. is now becoming one of the larger producers and additional plants are proposed for further expansion. The company now controls Central Iron and Steel and Phoenix Iron and Steel Corp. During the year they purchased the 600-ton blast furnace at Chester, Pa., which was put into operation last June.

Another small company which is carrying on a large expansion plan is Granite City Steel Co., which is going ahead with a $50,000,000 program. This program will about double the steel capacity of this company, which is now about 620,000 tons a year. The Supreme Court decision on basing point prices is a factor which makes this expansion program desirable.

A new steel plant is being constructed in Texas by R. G. LeTourneau, Inc., manufacturers of earth moving equipment. This steel plant, which will be adjacent to the company's manufacturing plant at Long Vue, Texas, includes two 25-ton electric furnaces and a plate mill. It is claimed that the plate mill will have a new type drive which makes possible the use of a comparatively small drive motor.

Texas is also the site of another large steel expansion. Lone Star Steel Co. is going ahead with its program for construction of a fully integrated steel plant and expect to be making steel in the third quarter of 1952. Included in the program are a 45 × 80-in., 2-high slabbing plate mill, and a 27 × 49 × 72-in. 4-high reversing hot strip mill. The open hearth capacity of the plant will be 500,000 net tons, which consists of four basic open hearth furnaces of about 200 tons each.

Lone Star Steel Co. was the first company to tap the government's $600,000,000 plant expansion loan fund. Lone Star Steel obtained a government loan of $73,425,201. The loan was obtained as a $23,425,201 loan out of the defense emergency fund ordered by NPA on RFC. RFC handled the $50,000,000 balance as a straight loan. Lone Star Steel is financing about $9,000,000 out of its own funds. The Lone Star plant will supply the demand in Texas and adjacent states for tubular products for oil country use. One of the important items in this expansion is the DPC blast furnace which Lone Star Steel purchased some time ago.

A new steel plant opened in Oklahoma. This is the Hoster Steel Corp. in Oklahoma City. This plant consists of an electric furnace and depends mostly on local scrap.

Pacific State Steel Corp. is adding two new open hearth furnaces to its plant at Niles, Calif. These two furnaces will be 150-ton units.

Kaiser Steel Co. announced a $125,000,000 expansion program at the beginning of 1951. This program will

provide facilities for production of 200,000 tons of hot-dipped and electrolytic tin plate. In addition, the program includes the construction of an additional 200-ton open hearth furnace, which will increase Fontana's capacity to 1,380,000 tons annually.

FOREIGN PLANTS

Canada is now the eighth largest steel producing country in the world and in 1951 had an output of 3,500,000 tons. Canadian steel companies are spending $100,000,000 in expansion and improvement programs, and it is expected that this will raise steel capacity to about 4,500,000 tons and blast furnace capacity will be raised to nearly 3,500,000 tons. Among the companies expanding, Steel Company of Canada has a $45,000,000 program; Dominion Foundries and Steel Corp. has a $12,000,000 blast furnace pig iron project at Hamilton; at Sault Ste Marie, Algoma Steel has a $10,000,000 stainless steel tube plant under construction; and Atlas Steels Ltd. at Welland is building a $1,600,000 cold sheet mill. Dominion Steel and Coal Corp. is expanding their Sidney, Nova Scotia mines and mills at an estimated cost of $23,500,000.

The Altos Hornos de Mexico mill at Monclova, Mexico has a $5,000,000 expansion program under way. Proposed expansion includes blast furnace improvements, and the addition of a new open hearth furnace and a new hot strip mill as well as other processing facilities. Finishing capacity will be increased from 115,000 to 185,000 tons a year.

In South America, Volta Redonda in Brazil is boosting its annual capacity from 420,000 to 660,000 ingot tons. A $41,000,000 steel plant is also being planned for Colombia. This will be the first plant in that country.

Total ingot production in Europe in 1951, not including Russian dominated areas, was at an annual rate of about 64,000,000 tons per year, or 10 per cent higher than in 1950. The chief producer was the United Kingdom who produced about 17,600,000 tons during the year. West Germany was the second largest producer and they produced about 14,000,000 tons. France was third with about 12,000,000 tons. Belgium was fourth with better than 5,500,000 tons. Luxembourg follows with 3,300,000, Italy with 3,200,000, the Saar with 2,800,000 tons, Sweden with 1,600,000 tons, Austria with 1,100,000 tons, Spain with 1,000,000 tons, and remainder scattered.

Steel production in the Soviet Union and in the European countries under its control is estimated at about 43,000,000 tons. Production within the Soviet Union alone has been estimated at about 33,000,000 tons. In the Russian zone of Germany steel production was about 1,400,000 tons, Czechoslovakia had a production of about 3,600,000 tons, Poland had about 3,100,000 tons, and Hungary produced about 1,300,000 tons.

The economic commission for Europe estimates that ingot production for Europe will be 82,500,000 net tons by 1953 exclusive of the Soviet Union. Of this 69,520,000 tons will be produced in Western Europe.

Great Britain is boosting its pig iron capacity about 560,000 tons and capacity will be about 12,320,000 tons in 1952, and steel production for 1952 is set for about 18,500,000 tons. A high note in the British steel picture was the inaugural ceremony on July 17 of the Margam and Abbey Works of the Steel Company of Wales. This is the largest single project carried out in Great Britain since the war and was estimated to cost 60,000,000 pounds. Product of the plant will be sheet and tin plate. Four British firms pooled their resources and between them formed the Steel Company of Wales. The new plant included an 80-in. continuous strip mill, three blast furnaces, two mixers, eight open hearths and a cold reduction mill. Another cold mill and tin plate plant are being built at Trostre.

One problem which faces England is denationalization of the steel industry. This was an important item on the conservative program and one which the Tories are pledged to carry out as the result of their election on October 25. Unfortunately, the Tories may run into snags because of the many financial complications involved, and because of the fact that there may be some reluctance to invest capital back into the steel industry again, if there is a possibility of the labor government going back into power and nationalizing the industry all over again. A second nationalization might not be carried out on such advantageous terms as was done the last time.

The nationalization of steel was relatively short lived as the industry was taken over only last February 15. It was done through the formation of a State Iron and Steel Corp. of Britain who became the sole shareholder in approximately 80 companies with about 100 other subsidiaries. Steel bonds were issued to the present shareholders on the basis of security prices during a certain period in either 1945 or 1948, whichever was more favorable to the present shareholders. Steel production in Great Britain did not do too well during 1951, and two factors were a sharp drop in imports of ore and German scrap.

Very little investment has been made in the iron and steel industry of Western Germany since the end of the War. Western Germany, however, would like to get approval to expand the steel plants of the August Thyssen Works and wants permission to spend 67,000,000 marks to boost its present output from 128,000 net tons to 1,100,000 tons. Coal shortages are a very important factor in German steel production in the Ruhr. At the present time 22 per cent of their current production is made with U. S. coal shipments to the country. Steel capacity is about 14,900,000 tons; iron capacity is about 11,800,000 tons; rolling mill product capacity is about 10,200,000 tons.

Norway is also expanding its steel industry. One of the factors in the expansion is the electric smelting of iron ore into pig iron. A new plant at MoiRana is expected to be the largest of this type in the world. This plant takes advantage of the country's cheap water power.

Steel production is also being expanded in Austria to over 1,000,000 tons. Most of the production of rod sections and wire will be concentrated at the Donawitz Works of Oesterreichisch-Alpine Montangesellschaft. The plant which was built during the war at Linz will be the center of sheet production. Special steels are produced primarily at Bohler Kapfenberg, Styria, and Schoeller-Bleckmann, Ternitz, Lower Austria. The Donawitz Works alone will have a pig iron capacity of 450,000 tons per year and steel production of 750,000 tons per year. The works at Linz remained unfinished during the war. This plant has six blast furnaces of

650-850 tons per day daily output and has too much pig iron capacity for the size of the plant. One of these blast furnaces has already been sold to Sweden while two more are to be sold. The remaining three blast furnaces will give an annual pig iron production of about 850,000 tons; steel production up to 450,000 tons is being planned.

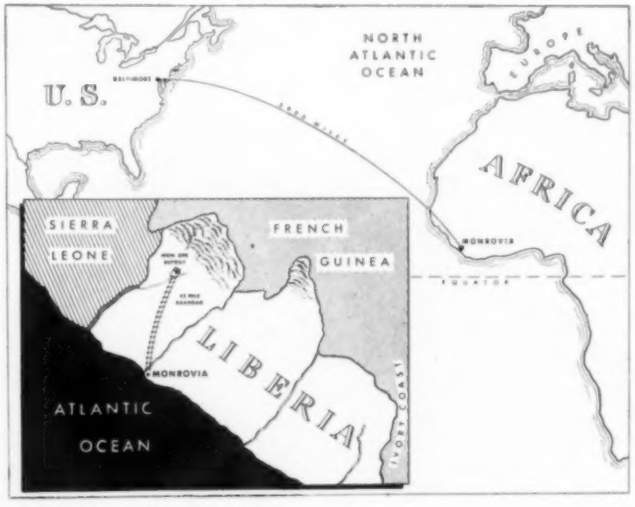
Austria had planned to go in for large scale electrification of pig iron production in order to save coke and to conserve much of the manganese content which is present in the Austrian iron ores. However, due to lack of power this project has now fallen by the wayside.

The government of India had a program, reported in last year's story, of building two integrated steel plants of 500,000 tons capacity each. Each of these plants was estimated to cost about $210,000,000. However, the finances of the government were such that it has been decided to shelve the projects for the present time, as outside capital was not available. One of the factors was that the government intended to nationalize the industry after running the newly built plants for ten years. The three major producers in India at the present time are being helped by the government to renovate and expand their facilities, and this will result in overall increases in steel production of about 500,000 tons per year or about one-third present capacity.

ORE AND RAW MATERIALS

The United States is becoming more and more dependent on foreign sources for some of its metal supply. In 1950 imports of iron ore were 9,500,000 tons or 8 per cent of the total, manganese ore imports were 1,804,000 tons or 93 per cent of requirements, chromite imports were 578,000 tons or 100 per cent of requirements, antimony imports were 13,500 tons or 92 per cent of the requirements, tungsten imports were 7900 tons or 80 per cent of requirements, lead imports were 520,000 tons or 55 per cent of requirements, tin imports were 122,000 tons or 100 per cent of requirements, cobalt imports were 4300 tons or 94 per cent of requirements, zinc imports were 429,000 tons or 41 per cent of requirements and copper imports were 644,000 or 40 per cent of requirements.

A new source of ore supply started feeding American steel industry when Liberian pits went into operation.



Steel companies in 1951 used about 128,000,000 tons of ore, 100,000,000 tons of coal, 67,500,000 tons of coke, 27,000,000,000 kwhr of electric power of which it generated 36 per cent. The industry burned 575,000,000,000 cu ft of natural gas and used 2,500,000,000 gal of fuel oil.

Summarizing the availability of iron ore supplies in 1951, about 96,500,000 net tons came from the Lake Superior District, 5,500,000 tons from the eastern district, 6,000,000 tons from the western district, 9,000,000 tons from the southern district, 2,500,000 tons from Canada, 1,100,000 tons from Venezuela, 300,000 tons from Liberia, 2,100,000 tons from Sweden, 3,000,000 tons from Chile, 800,000 tons from Brazil and 1,000,000 tons from other imports for a total of about 128,000,000 tons. By 1955 it is estimated that the corresponding figures will be about as follows: 103,000,000 tons from the Lake Superior District, 6,600,000 tons from the eastern district, 6,000,000 tons from the western district, 9,000,000 tons from the southern district, 7,700,000 tons from Venezuela, 1,100,000 tons from Liberia, 5,500,000 tons from Labrador-Quebec, and 6,600,000 tons from other sources for a total supply of 145,500,000 net tons. Thus, even by 1955, more than 70 per cent of the ore will still be coming out of the Lake Superior District.

Coal supplies are ample and the main limitation is in available freight cars; however, in spite of the availability of coal, coke is tight. It is estimated that production of coke in 1951 for all uses will be about 79,000,000 tons. Of this, about 8,000,000 tons will be produced in beehive ovens. About 38,000,000 tons of limestone were needed in 1951. Although supplies were ample, a shortage of transportation equipment was also encountered here.

Total ore shipments for the year down the Great Lakes were 89,069,817 tons. This compares with 78,165,306 in 1950. In addition about 7,500,000 tons were moved by rail.

During the last winter season, ore was shipped by rail from Minnesota to Chicago and Pittsburgh district plants of the United States Steel Co. These shipments required special facilities in both locations whereby the frozen ore could be thawed out and unloaded from the cars. This was done by using steam generated from old locomotives in the freight yards. About 2,000,000 tons of frozen ore were handled in this manner.

Great Lakes shipping is undergoing the largest expansion program of many years, at an estimated cost of over $100,000,000. Sixteen new vessels are being constructed for operation on the lakes, with an average capacity of 18,500 gr tons each. A number of other vessels are being converted from ocean to lake traffic. This conversion is being done primarily for speed rather than for economy. In converting the victory ships several of them were lengthened by 165 ft. This was done by cutting the old ships in half and adding a center section. One of the toughest projects in this conversion was the final voyage of the boats up the Mississippi River and across the Canal to Chicago prior to entering Lake Michigan. In some cases, clearances of only a few inches were encountered.

The first shipment of iron ore from Venezuela arrived at Sparrows Point on March 22, when the S. S.

Bethore delivered 23,850 tons of iron ore from the new mine in Venezuela. Bethlehem Steel Co. brought in about 1,100,000 tons of ore from Venezuela in 1951, and now plans to increase this to 4,500,000 tons per year.

The arrival of the S. S. Simeon G. Reed at Baltimore on June 22 with a shipment of Liberian iron ore inaugurated another era of ore supply. This was the result of the development which Republic Steel Corp. has accomplished in that area. By early 1952, two 23,000-ton ore carriers will be making the run regularly. Most of the ore is in lump form, suitable for direct charging into the open hearth. The ore body is estimated at more than 24,000,000 tons.

The Baltimore & Ohio Railroad also opened its new $5,000,000 ore pier at Baltimore in May of 1951. The first boat to unload was the S. S. Chilore, which unloaded 26,000 tons of high grade ore from Chile destined for Bethlehem, Pa. The Pennsylvania Railroad also announced plans for new ore facilities primarily designed to take care of the new Morrisville plant of the United States Steel Co.

The new low grade ore pit which the Ford Motor Co. and Cleveland Cliffs Iron Co. are reopening at Humboldt, Mich., will for the first time use iron concentrated on a commercial scale by the flotation method. This particular unit has several advantages: open pit mining can be used, the ore lends itself to the flotation method and the bed is located on a railroad 25 miles from lake shipping, with other shipping facilities also available. By 1953 production should be at a rate of 200,000 tons per year, and eventually 400,000 tons. The crude ore has 32 per cent iron content. After final enrichment, ore will contain 62 per cent iron. The ore in this pit is a jasper ore and thus is non-magnetic. Inasmuch as non-magnetic ore forms by far the largest bulk of taconite, the method used may offer good possibilities for operations on the range. This pit has not been mined since 1920. A plant may also be built to agglomerate the concentrate into pellets.

A laboratory process has been developed for which claims are made that it can make hematite ore magnetic. This would allow magnetic separation of the low grade ore, and could be very important, as magnetic separation is practical, but most of the low grade ore bodies are non-magnetic.

Bethlehem Steel Co. announced that it is going to develop newly found iron ore deposits in Morgantown, Pa. The ore is magnetic, lying from 1500 to 3000 ft below the surface of the ground. The discovery was made by aerial survey methods using a magnetometer. The ore has to be beneficiated.

Jones & Laughlin Steel Corp. opened a new open pit iron ore mine called the Schley Mine, located on the Mesabi Range near Gilbert, Minn. About 400,000 gross tons of ore were shipped from this mine in 1951 and it is expected that shipments will reach 500,000 gross tons a year.

Steep Rock offers promise for yielding large tonnages of high grade iron ore. The group controlling this body claim that proved deposits will produce 15,000,000 tons a year for 100 years. They also estimate there may be 4,000,000,000 tons in all. Exact quantities however are still unknown, and there may be more ore here than on any other range on the continent.

The ore body in Northern Quebec and Labrador consists of two major deposits. The one at Burnt Creek is known to have 400,000,000 tons of 65 per cent hematite. The other one, discovered recently, may be even larger. It is expected that iron ore will be shipped from the Labrador deposits during the 1955 shipping season when they expect to ship 5,000,000 tons of ore. In 1956 and 1957 output will be increased to 10,000,000 tons. Much of the ore, probably one-half of the total amount, is classified as bessemer grade. Estimated price of the ore at Seven Islands is about $4.00 a ton. It was hoped that the Labrador ore development would lead to construction of the St. Lawrence seaway. However, Congress decided not to go ahead with this at the present time. It is possible, however, that Canada may go ahead on their own.

Iron ore production at the Bell Island, Newfoundland, mines of Dominion Wabana Ore Ltd. will be increased by modernization and new equipment. Production should go from 1,700,000 tons a year to 2,500,000 tons a year in 1952.

Work is going ahead on the United States Steel development in Venezuela. The Orinoco Mining Co. awarded contracts recently for the dredging of a ship channel in Venezuela from the Gulf of Paria to Puerto Ordaz, the railroad terminal on the Orinoco River. This channel will provide passage for oceangoing vessels for 170 miles up the Macareo and Orinoco Rivers in Venezuela. From the ore dock there is a 90 mile rail shipment from the new mine.

In addition to United States Steel and Bethlehem, the M. A. Hanna Co. and Republic Steel Corp. are exploring for ore in Venezuela on their concession at Sabeneta hill.

In Peru an ore body of about 300,000,000 tons located near Marcona is under development. This ore body may be able to produce up to 500,000 tons annually.

Plans are also underway for the shipment of about 3,000,000 tons of iron ore from Brazil into the Pittsburgh District. The source of this will be Ita Bira Mountain which has about 100,000,000 tons of ore. The ore runs about 69 per cent iron. A new ore bed was

First ore from Liberia is shown being unloaded at the new $5,000,000 ore unloading dock of the Baltimore and Ohio Railroad at Baltimore, Md. This ore is destined for plants of the Republic Steel Corp.

also discovered in Brazil about 125 miles from Sao Paulo in the Vale da Ribeira.

It has been estimated that ore deposits in China are sufficient to satisfy the blast furnaces in that country which have a capacity of about 1,000,000 tons of pig iron a year. Ore supplies in Korea are less, but the large deposits, which lie mostly in the north, are of little importance during the present emergency. Manchuria used to produce about 3,000,000 tons of pig iron annually and has ample supplies of ore.

In the middle of 1950, sinter producing capacity was about 22,000,000 net tons per year. About 635 lb of sinter were charged into blast furnaces in 1950 per net ton of pig iron. Cost of producing sinter in various plants ran from 95¢ per net ton of sinter to $1.95. It is estimated that sintering capacity now stands at about 24,000,000 tons per year. The largest plant in operation is rated at 2,100,000 tons. About 41 plants are in operation. U. S. Steel alone, in six plants, has a sintering capacity of 2,500,000 tons.

A great deal of study has been made on the sintering process and most of the plants have been surveyed. These surveys indicate that most blast furnace operators do not feel that present sinter is as satisfactory as desired. The percentage of fines is too high. Some plants report lack of porosity, too much fusion and too wide a size range. The most common forms of raw material used for sintering are screened lake ores and flue dust. Some plants use fine ore concentrates of either hematite or magnetite and two plants use fine iron sulphate concentrates. Using screened ore and flue dust, production varies from 1.95 net tons for 24 hours per sq ft of effective grate area to a high of 4.08 net tons. Fuel used for ignition varies from 31,000 to 195,000 Btu per ton of sinter with an average of 100,000 Btu.

The program for taconite beneficiation is set at 15,000,000 gross tons annually by the beginning of 1956. In order to produce this, it will be necessary to process about 45,000,000 tons of taconite a year. It is expected that the supply of high grade iron ore from Mesabi will drop sharply beginning about 1956. It has also been estimated that it will take about four years to build the necessary beneficiation plants to process the taconite.

Taconite concentrates present a problem in agglomeration which has not lent itself too well to the sintering process because of the extreme fineness of the product. Pelletizing has been undergoing large scale experimentation. However, they have not yet obtained a grade of pellets which have sufficient stability to prevent them from being broken up during handling and shipment from the pelletizing plant to the furnace.

Other schemes for handling taconite powders range from briquetting with Portland cement or other binder, mixing with coal or other carbonaceous materials to form an iron bearing coke, and a nodulizing process using a rotary kiln. The rotary kiln has been used on a number of tests.

United States Steel's subsidiary, Oliver Iron Mining Co., started construction on two experimental plants for the recovery and agglomeration of taconite in Minnesota. The Mountain Iron plant, construction of which started on May 17, 1951, is a taconite concentrating plant. It is estimated that about 2,000,000 tons of taconite will be processed to extract 500,000 tons of iron oxide. Magnetic separators are used to separate out the ore. This plant should be ready for operation in the summer of 1952.

Oliver Iron Mining Co. is also building an agglomeration plant near Virginia, Minn. This plant will convert taconite concentrates into sizes suitable for shipment and use. The Virginia plant will experiment with the nodulizing and sintering methods of agglomeration. It will be the first combination sintering and nodulizing plant on the Mesabi range. Capacity will be 500,000 tons a year. The nodulizing kiln will be a brick lined cylinder about 12 ft in diameter and 350 ft long.

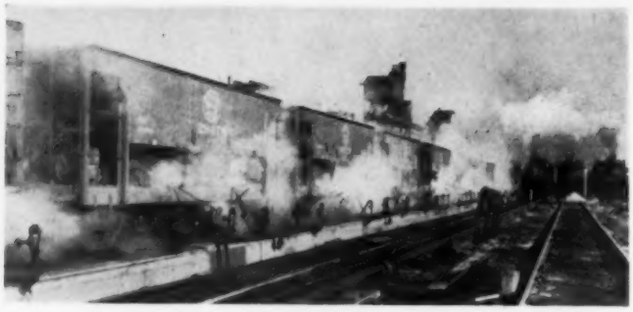
The Reserve Mining Co. controlled by Republic Steel Corp., Armco Steel Corp., and National Steel Corp., whose plant is located at Beaver Bay, Minn., awarded contracts in September for the first unit which will produce 2,500,000 tons of iron pellets a year upon completion in 1955. Estimated cost of this is $70,000,000. The plant is so laid out that it can be expanded up to 10,000,000 tons per year for a total cost of $160,000,000. The men working on this development predict production of about 20,000,000 tons from taconite pellets by 1960 and over 40,000,000 tons by 1970. This will require an investment of more than $750,000,000.

The methods used in this plant are based on the work done by Dr. Davis at the University of Minnesota on pelletizing of taconite. After the ore (25 per cent Fe) has been ground fine and the richer concentrate (64 per cent Fe) taken out by magnetic separation, the powdered ore is moistened and run through a rotating drum which forms them into balls. These balls are then roasted at a temperature of about 2300 F.

This same procedure has been carried out at a 70,000-ton plant at Ashland, Ky. Here the procedure is first to dump the concentrate into a steel cylinder where water is added and the resultant is put through a ball mill. The mixture is then pumped through a filter, from which the cake then goes through a balling drum which is 16 ft long and 7 ft in diameter. This is sloped so that the material gradually works its way down into the far end where 1-in. diam balls emerge. Balls are then burned in the furnace. There are problems in this heating process, since some of the balls are too green and do not stand up, and in other cases balls get too hot and fuse together into large clinkers. The product of this pilot plant has been added to the blast furnace burden in varying proportions running up to 70 per cent pellets and 30 per cent regular ore. Iron output was increased because of the higher iron concentration in the pellets. Coke and limestone requirements were as usual. This pilot work was the basis for authorization of participation in the taconite plant at Beaver Bay.

The Erie Mining Co., which is owned by Bethlehem Steel Corp., Youngstown Sheet & Tube Co., Interlake Iron Corp. and Pickands Mather Co., is operating a plant at Aurora, Minn., with a capacity of 200,000 tons of concentrates a year. Bethlehem is pelletizing and sintering at their Cornwall mines. If these operations are successful, a plant will be built at Aurora which will have a capacity of 2,500,000 tons annually.

In general, most of the ore preparation is a leeching process. Operations include crushing, grinding, screening, leeching with water, and if the ore is magnetic, the use of a magnetic separator. None of the various pilot plants seem to be using the same method, although all



Thawing setups for handling frozen ore helped the ore supply situation materially.

of them are trying to obtain a concentrate with better than 60 per cent iron with properties that will stand handling, freezing, etc.

Perhaps the most critical material in short supply is steel scrap. In order to produce 112,000,000 tons of steel in 1952, a target set by the government, 36,000,000 tons of purchased scrap will be needed compared with 29,700,000 tons which were used in 1950. About 36,000,000 of the 69,000,000 tons used were purchased in 1951. A very determined scrap drive is necessary. Steel plants require about 68 per cent of all scrap produced. Continued scrap shortage will force the industry to use a much higher proportion of pig iron in the production of steel. (The present ratio averages 48 per cent pig iron and 52 per cent scrap.) Hence, the construction program includes a large number of new blast furnaces.

On the other hand, the shortage in scrap is not deterring the authorization of several electric furnace programs. Follansbee Steel Corp. authorized five or six electric furnaces at Follansbee, W. Va. Newport Steel Corp. also plans to put in a battery of electric furnaces at Wilder, Ky.

A new scrap baler was developed during the year which, unlike other baling equipment, utilizes a combination of pneumatic and hydraulic pressure. The baler is driven by a 225-hp motor. The unit has a capacity of 75 tons per shift or 150 tons a day. It is claimed that the equipment produces a denser bale than other hydraulic equipment.

A new briquetting machine has been developed in the South which compresses cans into small bundles for use in blast furnaces. It is hoped that 1,000,000 tons of scrap yearly can be reclaimed by this method. Southern furnaces are already using this scrap and an electric furnace operator is also trying it.

A new coal preparation plant which cost $5,500,000 started operation at Georgetown, Ohio. This plant belongs to the Hanna Coal Co. It has an hourly output of 1275 tons of clean product, handling 1500 tons of raw coal. The important feature of this plant is that it proves that surface coal can be treated to give a coal which has a quality equivalent to that of deep mined coal.

Mechanically mined coal and the mechanical coal miners have met with favor with the industry. In 1950 about 4,000,000 tons of soft coal were mined by continuous miners. In 1951 this increased to perhaps 10,000,000 tons. Although this is only a small percentage of the total coal mined, it indicates a definite trend, which in turn will give the coke plant operator problems, since the mechanically operated miners will not be as selective as handmining.

A factor which may help in making coal more economical is the practice of using bolts to hold up the roof instead of the old fashioned timbering operation. This method is not only more economical, but enables more coal to be taken out of the mine.

The requirements for ferroalloys will be helped by the construction of a new ferroalloy plant at Marietta, Ohio. This plant is already in operation although it will not reach its full capacity for several years. When this plant is completed, 26 electric furnaces will be in operation. Two new processes will be used at this plant; one will make low carbon ferrochrome to very tight specification, and the other process will produce electrolytic chrome.

There are several general processes being tried to obtain manganese. Most of these involve recovering the manganese which is available in the slag piles of the various steel companies.

One of these processes under test by the Bureau of Mines, at Pittsburgh, consists of smelting the manganese bearing open hearth slags in a small blast furnace to get a high manganese pig iron. This is then partially oxidized in a bessemer converter to obtain a manganese rich slag. The phosphorous stays in the iron, making it useless. It has been calculated from laboratory work, that slags which contain 40 to 50 per cent manganese oxide could readily be produced by blowing manganese pig iron of about 3 to 4 per cent manganese down to about 0.8 per cent manganese. These slags can be further treated to yield a commercial product in a ferromanganese furnace.

There have been a number of variations of the above method proposed, using both low grade manganese ores and manganese bearing slags.

This process will probably be used in the manganese recovery plant proposed for Wilkes Barre, Pa. Here, anthracite coal will be burned in a 10-ft blast furnace, and slag will be brought from an adjacent steel plant.

One of the most promising new processes for recovery of manganese and iron from open hearth slag and low grade ores has been reported as a result of pilot plant operation in cooperation with the U. S. Bureau of Mines at College Park, Md. The process is primarily a pyrochemical and mineral dressing operation used in many other industries. It consists primarily of crushing and grinding, sintering in a rotary kiln with limestone, wet grinding and finally magnetic separation. Metallurgically the process has three steps. In the first, the slag is corrected so that it has a molecular lime-silica ratio of about 2. In the next step, the oxide phase is separated from the silica and phosphate phases, and in the third step the oxide phase is reduced to spiegeleisen or to iron and ferromanganese in a two-stage reduction. It is claimed that the concentrate will recover 75 to 85 per cent of the manganese iron in the original slag. This process has advantages over the previous one in that no blast furnace or converter is required, and no critical raw materials are needed. Materials required are slag, limestone, silica sand, some fluorspar and fine waste coke.

Some of the outstanding features of the process are as follows:

1. Process recovers, in the concentrate, from 75 to 85

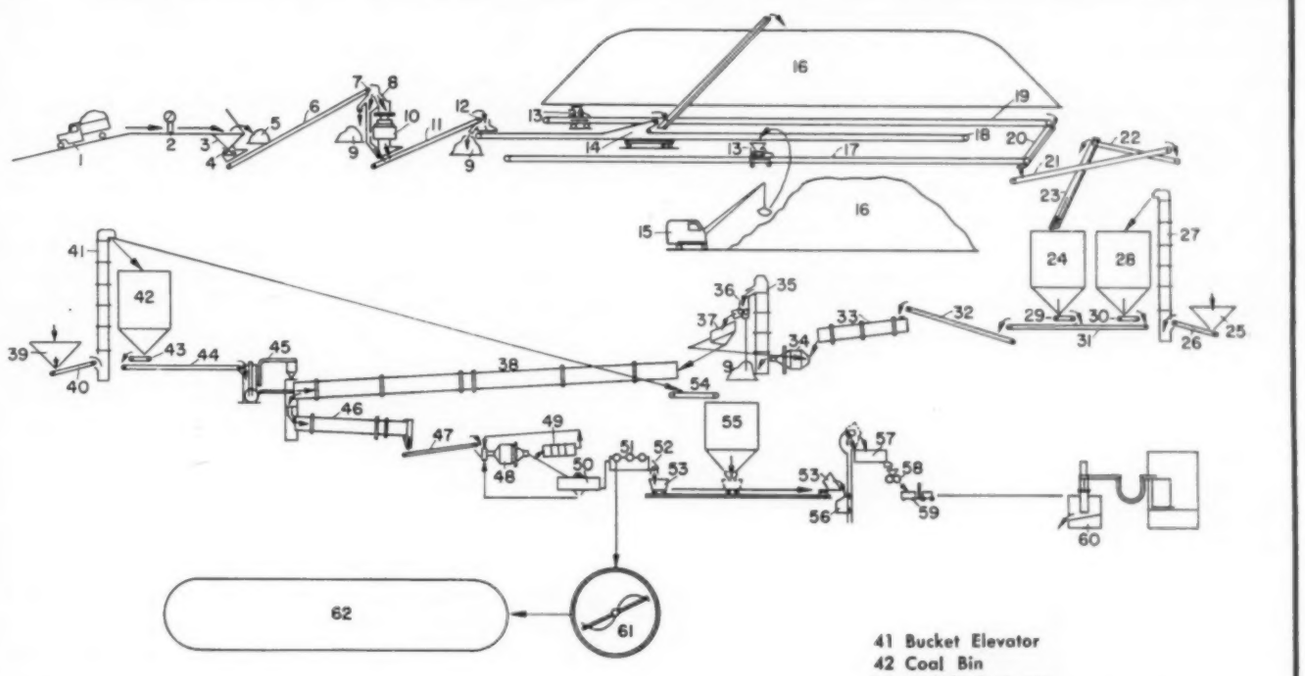
per cent of the manganese and iron contained in the original slag.

2. Process uses either flush slag or common mixtures of flush and tap slag.
3. Phosphorous content of the concentrate can be reduced to less than 0.01 per cent if such is desired.
4. The metallic content of the concentrate will approximate 50 per cent. If slags low in magnesia are used, the metallic content will be even higher. Ratios of iron to manganese will be determined by the ratio of the original slag.
5. The cost of producing the concentrate will approximate $3.90 per ton of slag processed or $7.80 per ton of concentrate regardless of the manganese content.
6. The magnetic concentrate can be used in many different ways:
   a. In a briquetted form, concentrate can be fed to a steel mill blast furnace to produce a higher manganese content in the hot metal.
   b. The briquetted concentrate can be added directly to the open hearth although the manganese efficiency will be low.
   c. The concentrate can be directly smelted by any suitable type of furnace directly to spiegeleisen. The ratio of iron to manganese in the spiegel will be the same as that in the original slag. Usually this will produce a spiegel containing roughly 30 per cent manganese.
   d. The concentrate can be used as an auxiliary feed by present ferromanganese producing furnaces.
   e. The concentrate can be reduced by two steps to low phosphorous pig iron and standard ferromanganese.

This process does not require enormous capital investment, such as is needed for blast furnace and coke oven plants.

It has been reported that the Cuyuna Range in Minnesota has about 500,000,000 tons of low grade iron ore which contains from 2 to 10 per cent manganese. As a potential source of manganese, this body compares

Flow sheet illustrates a new manganese recovery plant which shows excellent possibilities from pilot tests.



LEGEND

1 Dump Truck
2 Platform Scale
3 Truck Hopper & Grating
4 Pan Feeder
5 +6" Reject Pile
6 Belt Conveyor
7 Magnetic Pulley
8 Bar Screen
9 Tramp Metal
10 Cone Crusher
11 Belt Conveyor
12 Magnetic Pulley
13 Traveling Hopper & Feeder
14 Traveling Stacker & Conveyor
15 Clamshell Excavator
16 Slag Storage
17-23 Belt Conveyor
24 Slag Bin
25 Track Hopper
26 Belt Feeder
27 Bucket Elevator
28 Stone or Sand Bin
29-30 Constant Weight Feeder
31-32 Belt Conveyor
33 Drier
34 Ball Mill—Dry
35 Bucket Elevator
36 Magnetic Separator
37 Vibrating Screen
38 Rotary Kiln
39 Track Hopper
40 Belt Feeder
41 Bucket Elevator
42 Coal Bin
43-44 Belt Conveyor
45 Coal Pulverizer & Burner
46 Rotary Cooler
47 Drag Chain Conveyor
48 Ball Mill—Wet
49 Counter Current Classifier
50 Hydro-Classifier
51 Magnetic Separator
52 Screw Feeder
53 Batch Car
54 Belt Conveyor
55 Coke Bin
56 Skip Hoist
57 Mixer
58 Briquette Machine
59 Lift Truck
60 Electric Arc Furnace
61 Thickener
62 Tailing Storage

favorably with most of the other low grade deposits in the United States. A chemical leaching method would have to be used, but the beneficiation entails metallurgical and leaching problems no more complex than those encountered in other domestic sites.

Nickel production in 1951 was about 295,000,000 lb or 10 per cent more than 1950. Of this, 275,000,000 lb came from Canada. Most of these mines have expansion programs. Falconbridge Nickel Mines, Ltd. is increasing production from 25,000,000 to 40,000,000 lb annually; Sherritt Gordon Mines, Ltd. will be in production by the end of 1953 with a capacity of 17,000,000 lb in 1955. In July 1951, International Nickel increased their production 12,000,000 lb to 252,000,000 lb annually. The United States government Nicaro nickel plant in Cuba is being reopened with a capacity of 30,000,000 lb which will be available some time in 1952. National Lead Co. will also increase their production about 9,000,000 lb in the next five years. In addition the nickel mines in New Caledonia will up their production from the present 14,000,000 lb in 1951. Nickel prices went up during the year and the world base price advanced 6¢ a lb bringing the U. S. price to 56½¢.

All domestic users of pig tin were placed under allocation by the NPA last May 1 and conservation orders reduced the consumption of tin for non-defense purposes. In addition, the RFC was made sole importer of tin, and as a result prices in the world market have fallen more than 40 per cent (from $1.80 to about $1.10 per lb) since the RFC took over.

One item in short supply at the end of the year is zinc. This was particularly emphasized with the zinc cutbacks and allocations set up by the NPA. Many mills producing galvanized sheet are having trouble getting their requirements.

Most of the commercial domestic production of cobalt at the present time is a by-product of iron ore mining in Pennsylvania, and about 700,000 lb are produced annually in this manner. However, by the end of 1952 an additional 3,500,000 lb of domestic capacity will be available through new mines which are being developed. The largest of these new enterprises is the proposed Blackbird Mine at Forney, Idaho. The production of this mine is expected to be about 3,000,000 lb annually.

One of the worst pictures in raw materials is that of copper. Productive capacity in the United States has remained substantially constant for the last thirty years, but the demand has been upward. As a result, the price has been going up both for domestic and foreign copper. In addition, prices of domestic copper must go up even more because lower and lower grade ores will be used as time goes on. It is estimated that copper output in the U. S. for 1951 was about 940,000 tons. Copper scrap available in 1951 was about 850,000 tons, appreciably less than 1950. Copper imports in 1951 were much less than the 641,000 tons in 1950. One factor was that price ceilings in this country were less than the world market.

Aluminum is in short supply but large expansion programs are authorized. Under present expansion plans, the Aluminum Co. of America will have a capacity of 653,750 tons per year or 44.4 per cent; Reynolds Metals will have a capacity of 394,000 tons or 26.8 per cent; Kaiser Aluminum will have a capacity of 370,000 tons annually or about 25 per cent; and the new joint Anaconda Copper Mining Co., Harvey Machine Co. at Kalispell, Mont., will have a capacity of 54,000 tons or 3.7 per cent, for a total industry capacity of 1,471,750 tons in 1953. The new Kaiser plant at New Orleans, La., started to pour aluminum at the end of the year. Production in 1951 totaled 840,000 tons or about 17 per cent over 1950. About 550,000 tons of the expansion program is in new plants and 200,000 tons in existing plants. About 150,000 tons of this went into production by the end of 1951, most of it from existing plants.

A development in material supplies is the number of items now being allocated on a worldwide basis through an international materials group. Tungsten and molybdenum were two elements or materials first handled in this manner, and copper has also been added to the worldwide allocation program.

Titanium is a metal which is coming to the forefront, and several companies were organized to produce this metal. It is estimated that reserves in North America alone contain 110,000,000 tons of this metal. One important deposit is ilmenite in Quebec. This is an ore which contains iron and titanium and this particular ore body is estimated to have 125,000,000 tons. In Quebec, the first of five proposed stationary electric arc furnaces has been put into production to produce a high titanium bearing slag as well as a high grade melting steel. By the middle of 1952, the plant will produce 250,000 tons of slag containing 70 per cent titanium dioxide, and 200,000 tons of high grade iron.

The world's largest electric furnace is used at this plant of Quebec Iron and Titanium Corp. at Sorel, Canada. This furnace is 54 ft long and 25 ft wide. It is a six-electrode furnace, actually consisting of three single-phase arc furnaces in one shell. At present this furnace produces about 235 tons a day, of which 135 tons are concentrated titanium ore and 100 tons are molten iron. Capacity production on this furnace is about 300 net tons a day.

Titanium production is currently at the rate of about 500 tons per year compared with 75 tons in 1950. Present operations usually start with a mining company which manufactures a sponge which is shipped to plants where the metal is melted into ingots and finished into sheet, strip, bar, wire and rod. At present, the titanium metal is produced by reducing the oxide in a thermochemical batch process. In this process the oxide is combined with chlorine to produce titanium tetrachloride, and this is combined with molten magnesium which results in magnesium chloride and raw titanium metal.

An investigation was made to determine whether titanium and zirconium could be used as emergency substitutes for manganese. The results of these investigations indicate that these elements can probably be used not only as substitutes, but in addition may give very beneficial properties to fully killed steels. Titanium costs slightly more than double the price of zirconium. However, the better availability of the titanium and the better retention for this metal offsets the advantage of lower cost for zirconium. The studies on these materials were based on their effect in preventing hot shortness in comparison with the effect of manganese in eliminating hot shortness.

One material now in short supply for the first time since World War I is sulphur. This may affect steel

plant operations particularly pickling operations, and processes for treating pickle liquor may become justified if sulphur shortages continue.

A large new deposit of sulphur was discovered during the year by the Freeport Sulphur Co. at the mouth of the Mississippi River. This company will build a mining plant here which will have a production goal of 500,000 long tons of sulphur a year, making it the largest single sulphur development for some time. It is expected to be ready for operation in 1953, and should help alleviate the shortage.

BLAST FURNACE AND COKE PLANT

During the past half century, there has been a decrease in the number (but not total capacity) of blast furnaces, because of a trend to larger and larger units.

In 1911 there were over 473 blast furnaces in operation with an average capacity of 50,000 tons of pig iron. On January 1, 1951 there were 250 blast furnaces in operation with a capacity on the average of 290,000 tons. The increase in size is very apparent, although the number of furnaces is much less. Present rapid expansion of steel requirements, plus scrap shortages which make it economic to use larger proportions of hot metal, have resulted in authorization of a number of new furnaces.

In this program are 13 new blast furnaces upon which definite progress has been made: One for Armco Steel Corp. at Middletown, Ohio; one for Bethlehem Steel Co. at Lackawanna, N. Y.; one for Crucible Steel Co. at Midland, Pa.; one for Detroit Steel Corp. at Portsmouth, Ohio; one for Great Lakes Steel Corp. at Ecorse, Mich.; one for Weirton Steel Co., Weirton, W. Va.; one for Republic Steel Corp. at Cleveland, Ohio; one for Sharon Steel Corp. at Farrell, Pa.; one for Tennessee Products and Chemical Co. at Oneida, Tenn.; two for United States Steel Corp. at Morrisville, N. J.; one for Woodward Iron Co. at Birmingham, Ala.; and one for Youngstown Sheet & Tube Co. at Indiana Harbor, Ind. In addition, three more furnaces are being improved. These include one for Colorado Fuel and Iron Corp. at Pueblo, Colo.; one for Jones & Laughlin Steel Corp. at Cleveland, Ohio; and one for United States Steel Corp. at Youngstown, Ohio. The additional capacity from these thirteen new and three improved furnaces will be about 6,300,000 tons per year.

Also, Kaiser Steel Co. at Fontana, Calif., has a third furnace under construction.

In addition to the above, an additional 10 units with 3,100,000 tons of blast furnace capacity will be added by early 1954 if the following planned units go through. These include two at Newport, Ky. for Newport Steel Corp.; one at Trenton, Mich., for McLouth Steel Corp.; one at Claymont, Dela. for C.F.&I.'s Worth Steel Co.; one at Harrisburg, Pa. for Central Iron and Steel Co.; and one at Phoenixville, Pa. for Phoenix Iron and Steel Co. The program also includes one at Houston for Sheffield Steel Corp.; one at Granite City, Ill. for Granite City Steel Co.; one at Neville Island, Pittsburgh, Pa. for Pittsburgh Coke and Chemical Co.; and one at Sparrows Point, Md. for Bethlehem Steel Co.

Blast furnace expansion, in the manner similar to that of steel expansion, is being aided by loans from customers. Pittsburgh Coke and Chemical Co. is accepting loans from three customers, selling preferred stock to another buyer of iron, and selling bonds to an insurance company plus selling additional stock to stockholders.

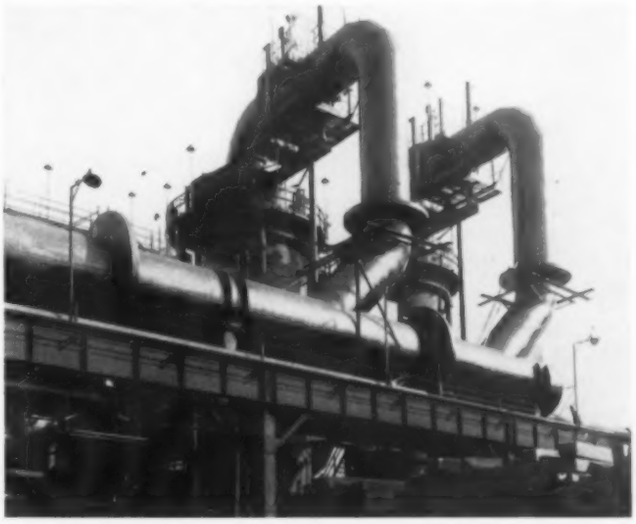
An example of the method in which existing blast furnace capacity is being expanded is that of No. 5 blast furnace at the Ohio Works of United States Steel. This furnace was completely rebuilt in the very short time of four months and 18 days. Not only was it rebuilt but the hearth diam was made 25 ft or 4 ft larger than before. As a result, the furnace will have an additional capacity of 112,000 tons annually over prior capacity before it was rebuilt.

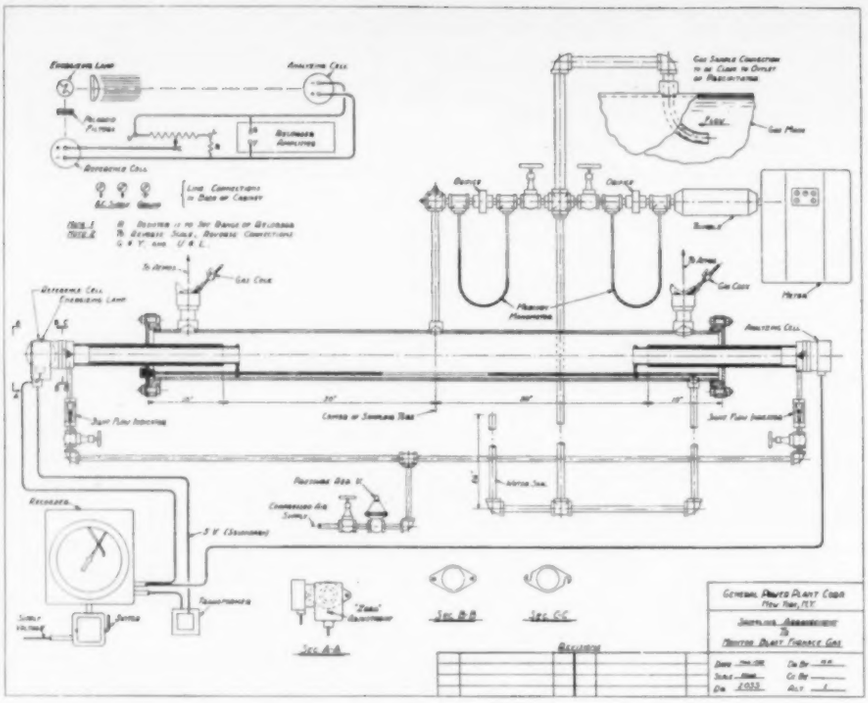
Blast furnace operations are still improving. Coke consumption in 1950 dropped 26 lb per ton of pig iron. Sintered ore is being used more widely and amount consumed in blast furnaces totaled 14,400,000 tons in 1950 for an increase of 46 per cent over 1949.

Reports on the use of oxygen in the blast furnace are not too encouraging. One furnace whose test results have been reported tried producing basic pig iron on oxygen enriched and normal blast. The results were not encouraging from the standpoint of product or the raw materials required. The effect of the oxygen enriched blast is quite similar to that of high temperature blast. Tests were also made on the ferromanganese blast furnace with the use of oxygen. In general, the results were encouraging in terms of fuel rates, the operation of the furnace and the production.

High top pressure is continuing to take hold. All six of the large units (27 or more ft hearth diam) under construction are to use high top pressure. Armco is building a 1400-ton high pressure furnace at Middletown, Ohio. The new stack of Great Lakes Steel Corp. at Zug Island will also be high pressure. United States Steel is running tests on one of the furnaces in operation at Edgar Thompson on high pressure and comparing results with an adjacent furnace which is not on high top pressure. So far the tests are inconclusive. In addition, five old furnaces are being converted to pressure operation. These are in addition to the eight furnaces now operating under high pressure in the U. S., plus

The new gas washers at National Works of the National Tube Co. are a major step towards smoke control. Gas is cleaned with a multiple water spray and subsequent electrostatic precipitators.





Schematic diagram of arrangement used to analyze blast furnace gas.

one in England. It has been estimated that these furnaces will produce at least 1,000,000 tons more pig iron a year than if they had been operated conventionally. Republic Steel's No. 5 furnace produced 48,005 tons of iron in September, 1951, for an average daily output of 1600 tons. This compares with 1400 tons which Republic would expect to get under conventional operation. Republic has converted 45 per cent of its total blast furnace capacity to pressure operation.

A continuous gas analyzer has been used on some high pressure stacks. With this instrument a series of runs have been made on several furnaces in an attempt to anticipate heating and cooling cycles of the furnace up to 5 or 6 hours before any trends would become evident in the hot metal analysis. From the last few runs, the operators have been able to predict and make correlation with an accuracy of 85 per cent. The instrument analyzes CO^2 CO and H^2 and this is combined with a direct reading computer and the high hydrogen alarm. The hydrogen alarm gives immediate warning of cut tuyeres, cooling plates or other failures which might introduce water into the furnace. This procedure has been incorporated into Republic's No. 5 blast furnace at Cleveland.

Radioactive tracers have been used in order to develop techniques for measuring the time of gas transit through blast furnaces and also to measure the rate of wear on the refractory linings. Radon gas has been used for gas transit, and Cobalt 60 for refractory wear. As a result of some of these tests it has been shown that the gas velocity at the center of the furnace may be 22 fps and that close to the walls is much lower, being about 8 fps. Other conclusions which have been developed are that the value of the CO^2 in the gas is lower at the wall. The gas temperature is higher at this point and the rate of descent of the burden is greater at the wall.

According to one authority the average U. S. blast furnace in 1950 has produced about 895,000 tons on its present lining. About 35 per cent have made 1,000,000 tons or more, 10 per cent 1,500,000 tons or more, 4 per cent over 2,000,000 tons. He also states that the average daily production from furnaces whose hearth diameters run between 27 and 28 ft is 1348 net tons. Production from furnaces having diameters of 25 to 27 ft is 1128 net tons, from 22 to 25 ft diam, 937 net tons, from 20 to 22 ft, 791 net tons, from 18 to 20 ft, 730 net tons. About 635 lb of sinter are charged per net ton of pig iron produced in the furnace.

In 1950, 86 blast furnaces had been equipped with carbon hearth linings. Fourteen of these involved a carbon bottom pad only, 51 a double carbon wall, and the remaining 21, single carbon walls. After an apparent lull in application, carbon hearths have rebounded in interest, with a number of new orders, including some extending up through the bosh and into the stack.

An all carbon lined furnace was built in England in 1949 with a hearth diameter of 18 ft 3 in. This furnace used only 9 in. of carbon in the bosh. The hearth of this furnace was built with corrugated blocks, and standard shapes were used in the hearth wall and tuyere belt. The hearth was spray cooled, the tuyeres were cooled with copper plates and the bosh was spray cooled. This furnace was blown in on April 4, 1949 and from a production standpoint it has operated satisfactorily since that time. In the first year of its operation, this furnace made 12 per cent more iron at a slightly lower coke rate than it did in an equivalent period of its previous campaign. There has been some trouble in overheating at the top of the stack. A second furnace was built at this same plant and this furnace has the same type of spray cooled corrugated hearth as used in the previous one. It was decided, however, to install normal cooling arrangements in the stack in addition to vermiculite insulation. This furnace was blown in on October 24, 1949 and has operated satisfactorily. This furnace also had an increase of production of 4 per cent in the first year. In February 1950, a third furnace at this plant was relined completely with carbon and blown in in April 1950. Some of the benefits which are claimed from

the use of the all-carbon lining are that it is safe to use thinner lining with carbon than with fireclay brick. Also, carbon increases the overall campaign life and furnace construction is simplified and hearth breakouts are reduced.

The British have carried on a number of full scale test runs on blast furnace operation at the United Steel Companies, Ltd. in England. Some of the conclusions found in these runs show that the elimination of fines from the burden combined with the use of the best coke available improve iron output and decrease coke consumption. Smoother operation and increased blast volume were also obtained. In addition, the use of dried and screened burdens promoted smoother furnace operation and increased iron output and also decreased coke consumption. In another series of tests, it showed that low volatile coal blending effected improvements in coke quality and also reduced coke consumption. As a result low volatile coal blending was adopted as a standard practice. Tests were also run using high percentages of sinter in the charge and these also resulted in lower coke consumption. The maximum sinter used was 67 per cent and it was believed that this figure could have been increased.

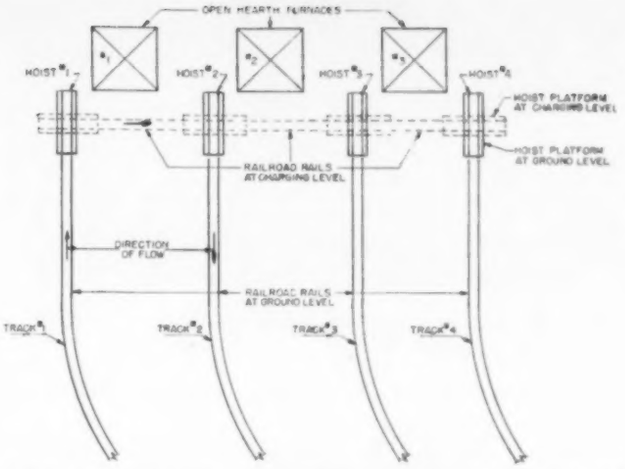
Work has been done at a steel plant in Sweden at which pig iron is desulphurized with the use of pulverized lime, since lime is one of the cheapest desulphurizing agents. In the process, the iron was desulphurized in a small 3-ton rotary furnace. Reducing conditions must be maintained which means that the furnace must be kept tightly closed. Desulphurizing time was very short, being as little as just a few minutes. The first plant is now in operation in Sweden. In this plant, a 15-ton unit, about 90 per cent of the sulphur in the metal is removed and costs are lower than in previous methods.

Some producers are trying again the Perrin process for desulphurization. This is a French process which has not been very widely used in this country. It uses a 50-50 calcium aluminate slag in the ladle. Sulphur is reduced very quickly. Other plant work has been pursued on the desulphurization of pig iron using calcium chloride. The indications from the pilot plant work are that the process has possibilities.

An international cooperative research project is underway on the low shaft blast furnace. Two low shaft blast furnaces are to be constructed, one at Liege, Belgium, which will have a 4 × 8-ft rectangular cross section, and the other at Oberhausen, Germany which will be a 6-ft diam cylindrical furnace with a height of about 16½ ft. Both furnaces are rated at about 100 tons and will use oxygen enrichment in their test work. Eight countries are involved in the program.

A low shaft distillation furnace is also in production in Germany using briquettes made of non-coking coal and ore fines. This furnace is only one-third the size of a conventional unit and yet tonnages are about equal to the conventional unit. Some coal tars and distillation gases are also recovered. It is claimed that costs are cheaper than in a conventional unit.

The experiments on the use of blast furnace slag as a neutralizer of waste pickle liquor which was reported last year are still going on. Results have been improved by dribbling the liquor on a moving belt which carries the slag.



Hoists for new material handling system at Armco Steel are located in front of and in between the open hearth furnaces.

Coke production in the first nine months of 1951 totaled 59,200,000 tons which is a gain of 13.5 per cent over the same period of 1950. Of this beehive coke production was 5,500,000 tons or a gain of 41.5 per cent. Total coke production in 1951 was about 79,000,000 tons, or 9.6 per cent higher than 1950.

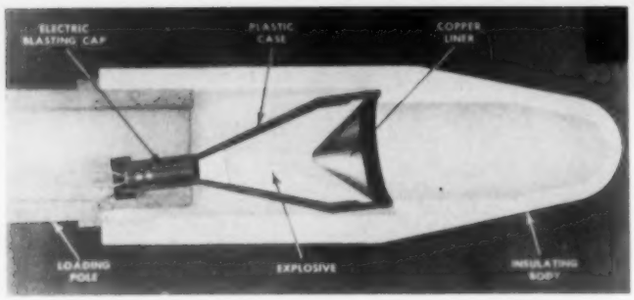
One development reported occurred at the largest coke plant in the Pittsburgh district. This plant has always been operated on high volatile coal but recently changed to a mixture of 20 per cent low volatile coal and 80 per cent high volatile. As a result of this change, there was a greater yield of pig iron, which in the case of this plant has to be balanced against higher transportation charges for the low volatile coal.

The coke shortage has resulted in putting into operation a large number of beehive ovens. This forced many operators to study the properties of beehive coke in order to get the best iron production. Some of the conclusions drawn from these tests are interesting. One was that there is a definite advantage in favor of the coke produced in the 48-hour period over the coke produced in a 96-hour period. The advantages were particularly apparent with regard to ash content and strength of coke as indicated by the fuel value. Also when using the same coals, it was noticed that there is a lower percentage of plus 2-in. beehive coke than there is plus 2 in. by-product coke. Finally, there were higher fuel values for the beehive coke than for the by-product coke produced from the same coals.

A great deal of experience is now available on bulk density control of coal charged to coke ovens. It has been found that one pint of oil per ton of coal will give remarkable results in smoothing out oven operation. In order to do the job properly, it is necessary that suitable equipment and apparatus are available, the character of the oil used is very important, and intelligent supervision is required at all times.

STEELMAKING

Open hearth charges have now increased to the point where the average furnace in 1951 had a capacity of 132 tons which is a gain of 13 per cent in the last six years. Electric furnaces have gained in capacity about 40 per



The jet tapper can be used in the open hearth with safety and economy.

cent since 1945, and now have an annual capacity per furnace of about 29,573 tons or about one-third the annual capacity of the average open hearth. There were 256 electric furnaces operating in early 1951, with a total annual capacity in 1951 of 7,570,830 tons of steel.

The total number of bessemer convertors is 41. The average capacity per unit is 137,097 tons and total bessemer capacity in the beginning of the year was 5,621,000 tons.

Several additional large 550-ton open hearth furnaces were put into production during the year.

It is estimated that about 70 new open hearths will be built for the additional capacity now on the program. In addition to this, there are 46 open hearths which will be rebuilt to have additional capacity. Seven new electric furnaces are also under construction and eight electric furnaces are being rebuilt for additional capacity.

Work is still continuing on the use of oxygen in the open hearth. Wheeling Steel has reported that it has been able to increase their production from 12.3 to 17.5 tons per hour by introducing oxygen in the burners. They use 600 cu ft of oxygen per ton, of this 520 goes into the furnace and the rest is used for straight carbon reduction at the end of a melting period. Lance or jet methods are used for carbon reduction and have not been used in the flame. The Wheeling plant generates its own oxygen.

An interesting method of charging the open hearth was adopted by Armco Steel Corp. at its Middletown Division. Hydraulic lifts have been built in this plant between each pair of furnaces. The buggy train is switched around on the ground level and placed on the lifts from which buggies are raised to the charging floor. By keeping the scrap cars on the ground floor, the plant is able to shift the cars around to the furnaces as they are needed without possibility of them being held up by a string of cars which is being charged into a furnace. The design was adopted after making a series of comparative tests on furnaces with a hot metal percentage of 44.2. It was possible to increase production out of a furnace from 13.30 tons per hr to 16.88 tons per hr. When oxygen was used to speed up combustion, heats were made at a rate of 17.62 tons per hr. The main difference, however, was due to the fact that increased material handling facilities were made available so that the scrap could be charged into the unit quite rapidly. Fuel consumption from the furnace during the run was 2,979,000 Btu per ton compared with a shop average of 3,604,000 Btu per ton. The increase in steel production was in the order of 15 to 20 per cent.

An innovation in the open hearth has been the use of the jet tapper. Jet tappers have been used for some time in the blast furnace and were recently adapted to tap the open hearth. The unit consists essentially of a shaped explosive charge which when detonated blows a hole through the refractory, giving a good clean tap. Some of the advantages are safe operation and a uniform full stream flow is available right from the start. Jet tapping reduces skull production, reduces manganese losses and enables the melter to tap when ready instead of waiting for extra temperature to be on the safe side.

Boron steels became important during the year and enabled producers to make steel with properties which could not be obtained otherwise because of the shortages of other alloying materials. Production of boron steels totaled about 600,000 tons in 1951. Demands for nickel and molybdenum exceed supplies by about 2½ times. In addition, there is practically no cobalt or tungsten available and the demand for chromium alsc exceeds supplies, although this shortage is not as severe as the others. The boron steels which are being developed are being made up around plain carbon steel which have a manganese range from 1 to 1½ per cent. Boron replaces several hundred times its own weight when it is compared with nickel, chromium and molybdenum in effecting the equivalent hardenability of these alloying agents.

The technical committee on alloy steels of the American Iron and Steel Institute announced during the year a new series of alloy steels which are leaner in alloy content than the NE steels of World War II. These steels are in the boron class and consist of smaller quantities of nickel, chromium and molybdenum as well as an additional small percentage of boron.

There are five new grades of steel which have been developed to conserve manganese, nickel, chromium and molybdenum. Not all of these steels have been developed for full scale production, but trials were made on a number of them. The first of these series is the 80Bxx series. In this series nickel content varies from 0.20 to 0.40 per cent, and the chromium content varies from 0.15 to 0.55, although most of the items in this series contain 0.25 per cent chromium. Molybdenum content varies from 0.08 to 0.15 per cent.

The second series of these steels is the 81Bxx series. This series contains from 0.20 to 0.40 per cent nickel, and 0.30 to 0.60 per cent chromium, and 0.08 to 0.15 molybdenum.

There is a third series of steels 94Bxx which at the present time consists of 94B17 and 94B20. These steels have 0.30 to 0.60 per cent nickel, 0.30 to 0.55 per cent chromium and 0.08 to 0.15 per cent molybdenum. The three series of steels: 80Bxx, 81 Bxx and 94Bxx have a minimum of about 0.0005 per cent boron.

An 86Bxx series has also been developed with one steel so far, the 86B45 which has a nickel content from 0.40-0.70, chromium from 0.55-0.75, and molybdenum from 0.08-0.15 per cent.

Another new steel composition series is the grade 81xx steels. This is a series which carries from 0.20 to

0.40 per cent nickel, 0.30 to 0.55 per cent chromium and 0.08 to 0.15 molybdenum.

Boron may be added to the steel in many ways, usually through various types of boron ferroalloys. Additions may be in the order of 0.5 to 4 lb per ton depending on the form in which it is added. There are, however, a number of limitations to the use of boron. In the lower carbon grades, greater boron content is required to obtain the maximum hardenability effect. Too much boron may make the steel hot short. The effect of boron on hardenability decreases with increase in carbon content to about 0.90 per cent carbon after which it has no further effect. Boron steels require a greater control in heat treatment and in addition more distortion is likely in heattreating boron parts. It appears that the use of 0.003 per cent boron gives maximum hardenability on steels, and greater amounts decrease hardenability. If free nitrogen is present, this seems to fix the boron as a nitride and reduces the effective amount of boron which is soluble in austenite. As a result it seems desirable to add about 0.1 per cent aluminum or 0.03 per cent titanium prior to the use of boron to deoxidize and to combine with the nitrogen which may be dissolved in the steel.

Work on all-basic open hearths has died down somewhat in this country. However, interest in this project has been kept up through trial operations on six furnaces in Europe, four in the United Kingdom and two in Holland. These furnaces have tried a number of basic refractories, but the one made out of 70-30 chrome-magnesite brick, with chrome ore as a coarse fraction, and using the magnesite for the fines, fired to 2732 F, has proven to be the best. One of the conclusions reached is that the roof should not be allowed to cool below 2192 F and this seems to be one of the fixed requirements for efficient operation. Tests were made on units as large as 150 tons. Potential advantages claimed for the furnace are increased output due to faster working (which in turn is a result of the higher temperatures that the basic roof can stand), less shutdown time, reduction in man-hours for bricklaying, less slag bulk, and possibilities for completely using or taking full advantage of liquid fuels. Basic roof costs were found to be five times that of the silica and the adoption introduced complexities in the design and construction.

A number of companies have installed zebra type roofs in their furnaces, consisting of alternate courses of silica and basic brick. These brick are laid up in a number of arrangements, some plants using wedges, some using keys, some mounting the adjoining rows flush and some setting the basic brick about 1½ in. out from the silica at the fireface. There is some difference in opinion as to the results, but increases in heats per campaign have been noted as high as 41 per cent.

From a report that one operator gave during the year, the conclusion would be that the fully rammed hearth has definite advantages over the burnt-in type. A 35 per cent decrease in installation time was indicated. Material cost for the fully rammed hearth is about 30 per cent over the semi-rammed construction, but man-hour requirements for installation for both types are about the same. Bottom delays on the rammed hearth indicate an advantage of 1½ minutes delay per heat less than that on the sintered hearth.

One steel company carried out a research project in which it measured temperatures of open hearth bottoms. The temperature studies show that rammed bottoms of the same depth have similar thermal gradients providing equal insulation is used. Drilled core data on these hearths also show that all bottoms had eroded to about the same depth after limited service regardless of composition or burning-in schedule. As a result of these temperature measurements, conclusions have been made as to better design methods and materials. A hearth construction which is suggested as a recommendation consists of 6 layers starting with 3½ in. insulation at the bottom, then 4½ in. fireclay brick, then a 9-in. soldier course of burned chrome brick, then a 9-in. soldier course of dense magnesite brick, and a 10-in. rammed layer and finally 5-in. of burned dolomite.

Carbon which has been used for lining some blast furnaces has also been suggested as a sub-hearth lining for open hearth bottoms. It was suggested that the carbon be used in sub-hearth linings in the form of machine blocks, but no applications have been made.

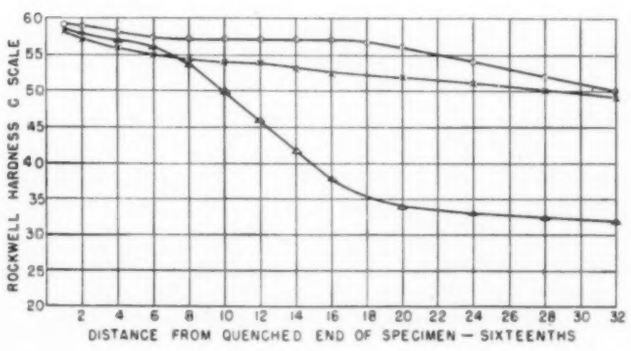
Many foundry men are shifting from the use of acid linings to basic materials in spite of the lower cost of acid refractories. One reason for this is that the coke quality is getting worse, having a higher sulphur content. Because of the greater control required in irons and particularly in the new ductile or nodular irons, additional sulphur or phosphorus in the analysis is not permissible. As a result it has become more economical to shift towards the basic lining.

A piece of equipment which offers possibilities for the steel industry is one which has been developed primarily for the determination of gas content of molten metals. This consists of a vacuum gage which is used on a small crucible into which a sample of the steel has been poured. As a result of the test procedure, an estimate can be made as to how much gas there is in the molten charge in time to treat the charge before pouring.

A spectrograph has been developed in France which is used for the direct reading of the spectrum lines of the alloys. Photoelectric cells are used to replace the

The effect of boron on hardenability is here shown to be almost as good as that of the 4340 steel.

LEGEND	GRADE	CHEMICAL COMPOSITION C	Mn	Si	Ni	Cr	Mo	B
X——X	4340	.40	.70	.27	1.84	.81	.25	NONE
O——O	86B45	.45	.81	.27	.51	.50	.21	.0012
Δ——Δ	8645	.45	.85	.29	.56	.52	.20	NONE



usual photographic portion of the unit. As a result the analysis can be read immediately by eye and analysis can also be recorded on a calibrated chart. These analyses can be made in times as low as one minute. If the analysis is unknown, a photographic plate may be inserted and the usual procedures used.

The Bureau of Standards has also developed a new simple practical technique for the quantitative analysis of solids using a mass spectrometer. The mass spectrometer should not be confused with the spectograph. In the latter unit the metal which is being analyzed is made incandescent usually by means of a spark and a spectrum picture forms the basis for the analysis. In the mass spectrometer materials which are analyzed are converted into positive ions which are then passed through crossed electrostatic and magnetic fields. These ions are deflected by different amounts depending on their mass and charge. The intensity of the various ion beams are detected by photographs or electrically. The deflections are a measurement of the element and the intensity gives the quantity of each material present.

Up to now, although the mass spectrometer has been used a great deal, it has been limited by the method for forming the ions which limited it to gases. The best available source so far has been a vacuum spark, but the variations have restricted this to methods which use photographic detection and such methods are limited in accuracy. In a new method developed, a monitoring collector is placed in the path of the unseparated ion beam and provides a measure of the total ions of all masses that are given off by the spark source at any instant. After separation, currents due to the ions of different masses are measured and a recorder records the ratio of each of these ion currents to the total ion current measured by the monitoring electrode. Since total and partial ion currents both fluctuate in the same manner, the ratio obtained on the recorder will be constant for ions of a given type.

A number of new ingot mold coatings have been tried as replacements for the tar coatings in common use. One of these is colloidal graphite suspension which resembles heavy black paint. The second is a non-inflammable paste consisting of aluminum and a binder. For both of these, the mold temperature is kept between 200 and 400 F for application. However, troubles developed in acquiring a thin uniform coating with these two new materials. A new applicator was developed similar to the spinner spray, but using a stationary nozzle and in which the material was atomized by compressed air. This apparatus gave an acceptable coating. Mexican graphite, a third coating also required the use of the compressed air sprayer. Tests were also made on various types of graphite-water mixture. As a result of the tests, this particular plant is using the colloidal graphite suspension.

Another operator experimented with 9-in. square discs of $\frac{5}{16}$-in. thick plywood on the bottom of molds. By so doing, the average ingot mold life was practically doubled, and in addition there seemed to be an improvement in billet surface quality. Although the disc burned, there was apparently no indication of any carbon pickup from its use.

A new hot top was recently developed for which cheaper maintenance and greater ingot yield are claimed. Hot top costs are said to be about 15¢ per ton below those in other plants of the same company. This new hot top has a heavier cast steel shell than the conventional unit which is lined with a refractory. The hot top weighs about a ton.

The National Tube Co. reported operational results with oxygen in bessemer blowers. The use of oxygen resulted in blow times of 9 to 10 minutes or several minutes less than normal time. This would result in a bonus of tonnage. The use of oxygen also makes it possible to charge at least five tons of scrap into these convertors which is two tons more than normal practice. Units used are 28-net ton acid convertors. Just slightly over 1 per cent pure oxygen added to the normal air gave the best results, and this amounted to 4000 to 6000 cu ft of oxygen for each blow. The most efficient rate of oxygen addition was about 1000 cfm, and this was most effectively introduced during the first four minutes. The chief purpose of these experiments was to melt as much additional scrap as possible in the bessemer converters during the period of time when there was a hot metal shortage. Blast rates ran from 25,000 to 33,000 cfm at 25 to 30 psi.

In Europe experimental work was also done on a 14-ton basic bessemer converter at the Domnarfeet Iron Works. In this plant the charges were dephosphorized with oxygen and carbon dioxide instead of air in order to reduce the nitrogen content of the product. Nitrogen was reduced about 0.006 per cent in the finished steel compared with 0.012 per cent with normal air blowers. The nitrogen content could be further reduced to about one-half the amount previously mentioned by using oxygenated air for the preliminary blowing. When equal parts of oxygen and carbon dioxide are used, they produce about the same temperature conditions as air blowing, but the blowing time is somewhat shortened. Gas consumption is about 1200 cu ft per metric ton of pig iron. One advantage of the mixed oxygen and carbon dioxide blowing is that pouring temperature can be adjusted to what is most suitable. In addition, if more than 50 per cent oxygen were used in the gas mixture, more scrap could be remelted during the blowing.

Similar tests have been carried out at a Belgium plant in which the bessemer was blown with air enriched with oxygen. The amount of oxygen in the blast and the times of admission were varied in the tests. These operations show that if air was enriched to about 30 per cent, using nothing but scrap additions for cooling the bath, the nitrogen was reduced from 0.01 per cent to 0.0083 per cent. If the bath were cooled with ore additions, the nitrogen was lowered to about 0.0060 per cent. Tests were also made in which the nitrogen content was reduced by charging a substance such as a carbonate which decomposes and evolves a gas which in turn lowers the partial pressure of nitrogen in the blast. Ordinary limestone was used, and the resultant carbon dioxide which was evolved behaved in the same manner as the carbon dioxide blast mentioned in the Swedish experiments, and in addition broke down to carbon monoxide and oxygen. A minimum of 40 lb of limestone was required, and 300 lb of limestone per ton

The use of vermiculite insulation enables the shipment of red hot ingots over long distances.

of pig iron eliminated one-half the nitrogen. By combining these various methods, using air enriched 30 per cent, and using ore plus limestone charged to the converter, the nitrogen in the resulting steel could be reduced to figures as low as 0.004 per cent which is comparable with open hearth steels. Phosphorous could also be reduced by this method. Tests were also made using steam and oxygen mixtures. These gave even better results, and reduced the nitrogen content to about 0.002 per cent. As a result of these tests, it was concluded that blowing enriched air or mixture of steam and oxygen would produce basic bessemer steels with very low nitrogen and phosphorous. The ductility of the steels was excellent and equivalent to normal open hearth steel.

Electric furnace steelmaking made further gains during the year. Electric furnace production during the year was about 7,100,000 tons compared with 4,900,000 tons of bessemer production. Production would have been still higher if adequate scrap had been available. It requires perhaps only one-half the investment cost to build an electric furnace plant than that required for a corresponding open hearth plant. However, the electric furnace cannot compete in general with large open hearths where blast furnace hot metal is used as a part of the charge. It may be able to compete, however, with medium sized open hearths where blast furnace hot metal is used as a part of the charge. It may also be able to compete with medium sized open hearths which use a cold metal charge. Electric furnace sizes have also increased markedly. Two 125-ton units are being built for Northwestern Steel and Wire Co. at Sterling, Ill. Three 90-ton units are under construction and one plant plans to have three new 100-ton units. Based on present projections, electric furnace capacity may be 9,000,000 tons in 1953.

The trend in converting sidedoor charging to top charging on electric furnaces has continued throughout the country. In most cases this change results in increases in production. An example of this is the 70-ton electric furnace which Republic is changing in Chicago where it is expected that the furnace will yield additional 50,000 tons a year. In some of these cases, transformer capacity is being increased; for example in the Republic furnace above, capacity has been increased from 12,500 kva to 20,000 kva.

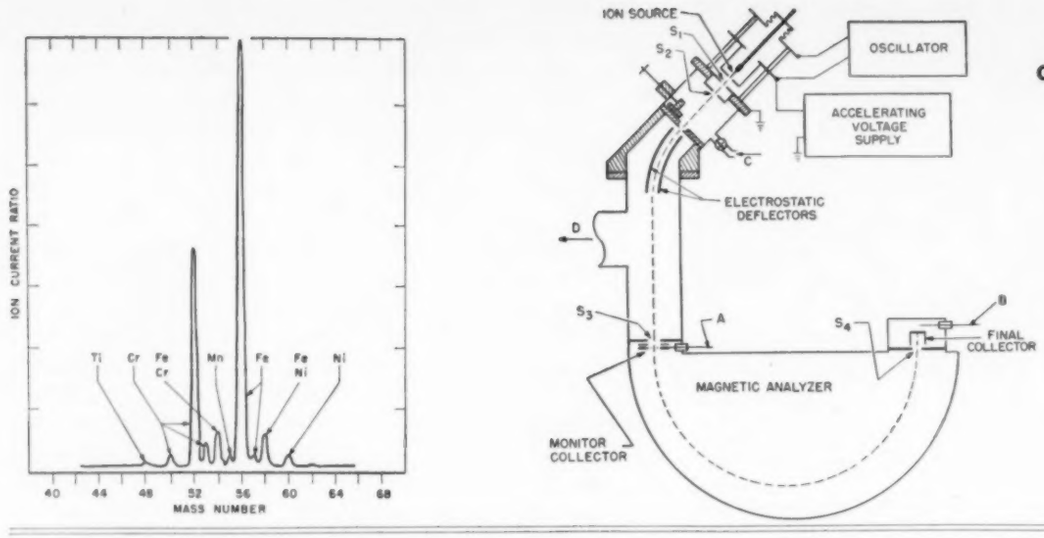
During the year the first induction stirrers for production steel melting furnaces were ordered in this country. These units have been used in Sweden for some time. The stirrer will be used on the first of three 80-ton electric furnaces which are being installed by a steel company. The use of such stirrers has increased production, with claims of increases as high as 20 per cent reported. Other improvements claimed are in the quality and cleanliness of the steel, better slagging conditions and better temperature control. The stirrer induces flow in the molten bath which results in intimate contact and faster reaction between the slag and the molten steel. The electric stirrer causes agitation in the bath through the introduction of a moving electromagnetic field.

Some of the rarer metals are being used in the electric furnace particularly to remove sulphur and gases in high quality steels. These are used in the form of an alloy known as mischmetall and consist of cerium, neodymium, praseodymium and lanthanum.

Bethlehem Steel recently added a 75-ton electric furnace at its Pacific Coast plant at Los Angeles. This is Bethlehem's largest electric furnace. Some of the details of this furnace are interesting. The unit uses three 20-in. electrodes which are energized by ninety 1½ in. diameter flexible copper conductors. All connectors are silver plated for best contact. The furnace shell is 20 ft diameter made of 1⅛-in. steel plates and is lined with a 1 ft thick layer of high heat resistant refractory brick. Furnace controls are hydraulically operated from a centralized control panel and electrode adjustments are done with a fully automatic electronic regulator. The furnace takes 4½ to 5 hours for a heat.

Research and development work on continuous casting continued during the year. One large steel equipment builder was licensed to engineer and fabricate such machines. This particular equipment is largely automatic and consists of a reservoir which is fed intermittently from a melting furnace. This metal is poured continuously from the reservoir into a copper water-cooled mold. The liquid metal solidifies in the mold and is pulled out by withdrawing rolls. Cutoff equipment below this cuts off the casting to any desired length. It is claimed that the machine can cast billets or slabs in various sizes. One steel company has been using it for casting steel in both carbon and stainless grades. This company in its pilot plant has cast billets up to 4½ in. in diameter at speeds up to 60 in. per min. and slabs 3 x 15 in. in cross section at corresponding speeds, or about 15 tons per hr. It is expected that further refinements will give much greater speeds. This equipment is at present being used in the casting of brass and copper and claims are made for savings from $5 to $10 over other continuous casting methods.

Experiments are being carried out on another type of semi-continuous casting equipment. In this operation, steel is poured into a horizontal ladle which discharges into a horizontal revolving drum. A spiral thread is shaped into the drum where the hot metal is thrown by centrifugal force. The hot steel in the thread



On left is seen mass spectrum obtained by new NBS method. Constituents of stainless steel sample are given immediately from the peaks of the curve. The schematic on the right shows principles of operation of mass spectrometer. Ions which pass through slit S_3 travel around curve at different radii depending on mass of ion. Amount passing through final cooler gives analysis of material.

unwinds as the drum rotates, producing a bar with a cross section which is equal to the depth and width of the thread and the length equal to the circumferential length of the thread.

Another continuous casting process was experimented with during the year. Although not new it is a refinement over some previous ideas. This unit consists of a moving mold consisting of two steel belts revolving over drum openings. The outside of the belt mold wall is spray cooled by water. The molten metal is introduced between the belts, and moves forward and solidifies as the belt goes through the mill. Experiments have been made on aluminum slabs weighing about 25 lb.

An aluminum wire mill is installing another type of equipment for casting aluminum rod. This machine uses a casting wheel in which molten aluminum is injected continuously into a V-shaped groove as the wheel rotates. The groove is closed by a moving metal belt, and the aluminum solidifies while being cooled by running water at the bottom. After the rod becomes sufficiently rigid it is guided into a rolling mill. The section cast is an equilateral triangular section $\frac{7}{8}$ in. on the side. Speeds are from 10 to 30 fpm, and about 1000 lb of aluminum is cast per hour. Scrap loss from pig to rod is less than one per cent.

The work on the continuous casting of steel which was reported last year now indicates that the method would justify construction of a plant for regular production which would cast crosssections with areas up to 40 sq in. Such sections would be suitable for rolling bars, wires, rod, narrow width strip and other products. A mold with a 100 sq in. crosssection has been under test. If this works out it would mean that continuous casting could be applied to about 30 per cent of the industry's tonnage. It may be possible to cast still larger sections.

ROLLING MILLS

Output of flat rolled products from hot continuous mills in 1951 was almost 36,000,000 tons or 43 per cent of all hot rolled steel. This is about four times the tonnage from such mills in 1936 when this kind of production was 21 per cent of the total.

In addition to the new rolling mills which have been installed, production capacity has been increased in the last few years approximately 25 per cent due to increased delivery speeds alone. This increase in speeds covers all types of mills from bloomers to finishing facilities. Delivery speeds on hot strip mills run now from 2000 to 3000 fpm. Top speed on rod and wire mills is 5000 fpm. Temper rolling units are up to about 5000 fpm and cold reduction mills are up to 7000 fpm. Speeds of auxiliary equipment have gone up correspondingly. With increased speeds, better and more accurate electrical control has been necessary, and in fact much of the success of the increased speeds has been due to refinements in such control.

As an example of increased production, the addition of rotating regulator controls on a blooming mill increased production on this mill by about 20 per cent. This could only be done, however, because the existing motor had sufficient capacity.

The new Fairless Works has the most powerful drive ever used for a universal slabbing mill on its 45-in. unit. Horizontal rolls are driven by two 6000-hp, 40/80 rpm reversing motors, assembled as a 12,000-hp double armature twin motor drive. Combined momentary torque capacity will be 4,330,000 lb ft. Each 6000-hp motor has two 3000-hp armatures mounted on a common shaft. Vertical rolls will be driven by a 4000-hp, 60/150 rpm double armature reversing motor. A duplicate of this universal slabbing mill is also being built for a midwestern plant. This mill will have vertical roll drives working through universal vertical spindles, enabling quick roll changes from slabs to blooms.

A 40 x 96-in. 2-high reversing intermediate bloomer is also being installed at the Fairless Works for the intermediate breakdown of ingots. This mill will reduce large blooms from the primary blooming-slabbing mill to sizes suitable for reduction in the continuous billet mill. This mill will be driven by 4000-hp twin drive motors.

An 80-in. continuous hot strip mill is being built for the Fairless Works. This mill will roll slabs 4-8 in. thick and from 8-20 ft long into coils up to 3200 ft long. Coiler speeds will go up to 2200 fpm. Mill has a vertical edger, scalebreaker, broadside stand, four universal

roughing stands, six finishing stands, runout table and coilers.

Fairless Works will also have a 30-in., 6-stand continuous vertical and horizontal billet mill, and a 21-in., 4-stand, continuous vertical and horizontal billet mill. In addition, there will be a 10-in. bar mill with a delivery speed of 3000 fpm, which will be one of the fastest ever built to roll rounds, squares, hexagons, angles and flats. A 5-stand, 48-in. tandem cold mill with a delivery speed of 7000 fpm and 2-stand, tandem 48-in. temper mill with a delivery speed of 3900 fpm will be used on tin plate. A 4-stand, 80-in. tandem mill with a speed of 3100 fpm and a single stand 4-high, 80-in. temper mill will be used for sheet.

On the West Coast one steel company rebuilt a 16-12 in. bar mill in a period of about three weeks. Production loss was slight because of the fast rebuild which in turn was due to excellent preliminary arrangements and planning.

A mill in the Pittsburgh district which for several years has been using diamond and square rolling stated that this operation successfully rolls seams, spongy surfaces and other defects out of semi-finished products on the secondary mills. This reduces scarfing and chipping to remove defects. As a result of this experience, this plant is installing several new mills with this type of reduction for rod and bar production.

Small packaged cold strip mills were put on the market during the year. Each of these units is furnished as a fully equipped mill with roller bearing mounted rolls, recirculating cooling system, guides, tension reels, wrappers if desired, strippers and drives, all of which are mounted on a fabricated base which serves as roll and lubricant cooling reservoir. These units come in three sizes: 2½ in. and 10 in. x 10 in.; 3 in. and 16 in. x 16 in., and 4½ in. and 22 in. x 22 in. The mills can be used for rolling copper, brass or aluminum, low and high carbon stainless and alloy steels at speeds of 500 to 2000 fpm. Thicknesses can be reduced from 0.050 down to 0.002 to 0.004 in. The mill can also be furnished for one-way rolling or for reversing service.

As a result of demand for aluminum strip coils, cold rolling mills have now been developed which are able to produce aluminum foil in thicknesses as low as 0.00025 in. at speeds up to 3000 fpm. Two recent installations roll such foil at widths up to 42 in. These units consist of a 4-high roughing mill, and a two-high finishing mill.

Kaiser Steel Corp. has been able to roll wide flange beams on its 29-in. structural mill. This is a cross-country mill. With normal practice it cannot be used economically as a wide flange beam producer. However, Kaiser modified this mill successfully, and for the first time, wide flanged beams are being produced on the West Coast. Most universal mills which make wide flanged beams have both vertical and horizontal rolls, whereas Kaiser's 29-in. mill has only horizontal rolls. The maximum size beam that can be rolled is a 16-in. wide flange, rolled in 11 passes directly from the bloom or from beam blanks. By changing rolls, this mill can be used to produce angles, channels, standardized universal plates and other sections. Following the same practice, Phoenix Steel Co. is also rolling wide flange beams on its 24-in. structural mill.

Powder metallurgy has always been limited by size of the objects which could be cast. A plant in Germany is reported to be rolling strip from iron powder, thus eliminating the size factor. Although the cost of the powder is high, the process may be useful for certain special applications.

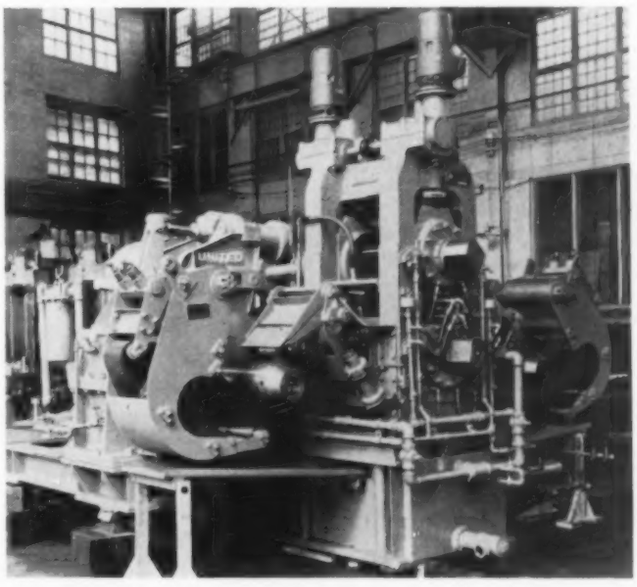
A processing scale breaker introduced recently features comparatively small rolls over which the steel strip is bent. It is claimed that this gives easier and quicker breakage of the scale, with resultant faster pickling time and reduced acid consumption.

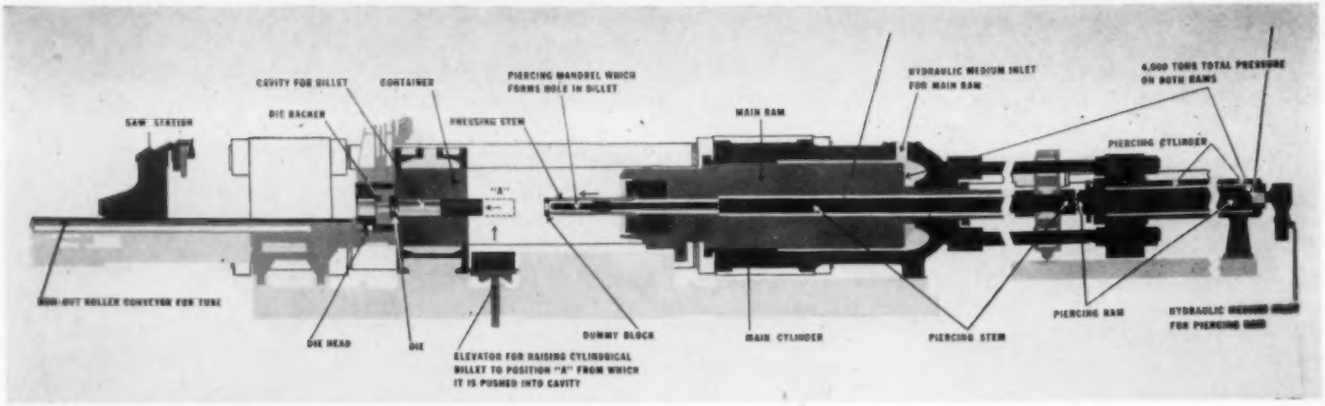
A unique straightener for rounds eliminates the use of all guides. This design uses seven straightening rolls, three on the entry end and another group at the delivery end. Each roll group is composed of one large driven roll and two idler rolls disposed at an angle of about 120 degrees to each other. Located between the two roll groups is a middle idler roll which deflects the pipe during the straightening operation. This roll arrangement eliminates the use of all guides and confines the bar or tube to the pass line throughout the straightening operation. Straightening speeds vary from 60 to 240 fpm.

A roller table bending machine was developed during the year capable of cold stretch forming a number of structural and sheet metal parts which conventionally are hot formed. This is one of the most powerful machines of its type and will stretch metals up to 2½ sq in. in crosssection. The machine provides variable stretch control. It consists of a stationary chuck table, a heavy rack and direct-connected hydraulic cylinder on the table gear, which is meshed with the rack and upon which the dies are mounted.

Beta ray gages are supplementing the X-ray gages in measurement of thickness of flat rolled steel products since the circuit is simpler. One difference between the beta ray gage and the X-ray is that the maximum thickness which can be measured with the beta ray is much less, being only about 0.050 in. because of the low penetrating power of the beta ray. The operating gap is also relatively small, being under 3 in. which com-

This 3 and 16-in. x 16-in. package mill was developed for high speed finishing of steel strip.





Extrusion methods for forming both ferrous and non-ferrous materials made enormous strides during the year.

pares with the smallest X-ray gage in use. The small gap is necessitated because the beta rays have a tendency to fan out in a large arc. Principle use of this gage would be in tin mill shear lines. The installation is simple and inexpensive. These gages may be of two types, absorption and back scatter. The latter requires mounting on one side of the sheet only. Gages can be used to measure both total thickness and coating thickness.

A non-contacting roll temperature measuring unit was developed during the year which can be applied to rolls with diameters down to 9 in. and to flat surfaces. The units work on the principle that a moving object carries with it a thin layer of air which has the same temperature as the object itself. The temperature of this air is measured and recorded on a recorder.

A magnetic sheet separator has been developed which by giving steel sheets the same polarity, cause them to repel each other, so they separate at distances from $\frac{1}{8}$ to $\frac{3}{4}$ in., depending on the weight. When one sheet is taken off the pile the underlying sheet floats up.

Pipe capacity has increased very markedly and mills for this product have expanded perhaps more rapidly than that of any other product in the finished field. In the last three years, pipemaking capacity has been increased 43 per cent, reflecting the demand for pipe for oil lines, gas lines and other such units. Capacity as of January 1, 1951, was 12,500,000 tons per year, and a number of mills are still under construction.

Equipment has been built for induction welding of pipe and tubing. The mills are substantially the same as those in a resistance weld mill for cold forming coil strip or skelp into pipe. The new feature is the induction welder. Among other features are that hot rolled stock can be used without being cleaned, pickled or oiled, and open hearth as well as bessemer steel can be used with equal success.

The development of nodular iron led to an investigation on the hot working properties of this material. As a result of these investigations, nodular iron has been both hot forged and rolled on an experimental basis. Higher rolling temperatures are required, and the hotter they are, the better the rollability properties. Because of edge cracking, the yield on width has been held to about 80 per cent. Both forgings, bars and plates have been made in the laboratory setup. The edge cracking is apparently the only serious problem in the hot rolling or forging of the nodular iron. This seems to depend on surface condition. Edge trimmed billets have a minimum of cracking, but sand cast ingots edge crack severely.

Extrusion of steel made good strides during the year, with a number of plants starting construction on mills or presses for the extrusion of steel products. Extrusion has always been an established process for non-ferrous materials but has not been extensively used in steel. The recent growth of the process is primarily dependent on developments of lubricants and dies, and on the development of large presses. In addition, technical knowledge of the plastic nature of cold steel has helped in engineering units which require much less power than was previously believed necessary. Advantages of the process are that it gives cold work properties to the steel, reduces machining time and costs, and saves the scrap material which would normally result from the machining process; in addition, a smooth surface is obtained with good tolerances.

One of the biggest applications of cold extrusion has been in making shells for ordnance purposes. However, one manufacturer is now set up to produce small industrial products such as shock absorber cylinders, gear blanks, pulley hubs, bearing housings, hub and axle components, etc. This company claims cost savings up to 55 per cent compared with the conventional ways of hot forging, drawing or stamping the steel.

One operator in the cold extrusion field claims that the success of its procedure depends on the metal preparation and coating process. This manufacturer cleans, pickles and applies a phosphate coating and special developed lubricants to the steel. This coating gives a heat resistant and lubricating surface which adheres exceptionally well to the steels even though it is subjected to very high pressures in the cold working and pressing operation. In addition to making cold extrusion practical, the use of the lubricant gives very great economies in tube and wire drawing, deep stamping, cold heading and other similar cold working operations.

Studies in the cold extrusion operation show that some of these phosphate coatings are as good as an electrolytic metallic coating of zinc. In the technique of the operation they have shown that small die angles give the lowest extrusion pressures and result in the best metal flow.

The phosphate coatings may be applied by immersion, spraying or flooding. These highly absorbent coatings are then covered with a special organic lubricant which reacts chemically with the phosphate coating and is absorbed.

Hot extrusion is also underway and the National Tube Co. is planning to produce various sizes of pipe by hot extrusion, using the Ugine-Sejournet process. In this process, the red hot bar stock is pushed through a circular die by a 2500-ton hydraulic press.

Using the same process, hot extrusion will also go into operation early in 1952 at the Watervliet, N. Y., plant of Allegheny Ludlum Steel Corp. The company will extrude stainless tube rounds and other shapes, including high speed, stainless and special alloys. This will be done on a 1500-ton hot extrusion press. Hot salt furnaces for reheating billets will be used.

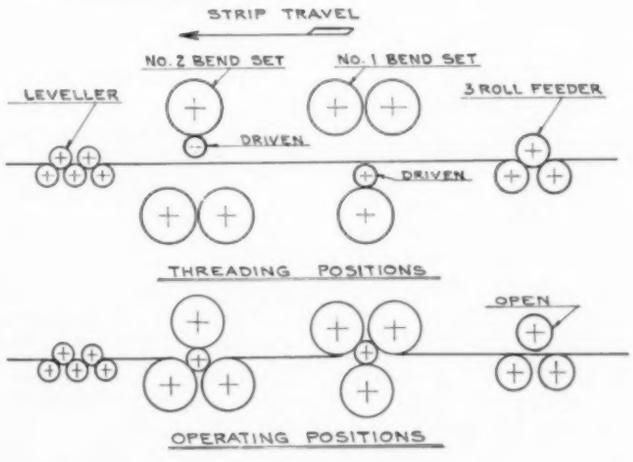
FINISHING

Shortages in raw material supplies affected tinplate operations as the steel industry is dependent on imports of tin. The greater tonnage of tin plate shipped was made by electrolytic methods which use less tin than the older hot dipped methods. Producers were, however, limited by allocations set by Washington.

One of the methods which will save tin even above the savings given with the electrolytic method is differential coated electrolytic tin plate. It is claimed that savings of tin up to 50 per cent are possible with the process in which different coating weights of tin are deposited electrolytically on either side of the strip. One side of the plate may be coated with 0.25 lb and the other side may run 0.5-1.0 lb per base box. The thinner side can also have heavier coatings for atmospheric protection when so desired. The lightly tinned side is marked with a special pattern which enables the can makers to identify the thinner coated side. The first shipment of this product was made on last March 7, and by November 1 more than 200,000 base boxes had been produced and shipped.

The canning industry is also going back to the so-called tinless black plate, some of the manufacturers having found that cans can be made of tinless steel and low tin solder at speeds comparable to that used with tinplate cans. Other tin free cans using a special plastic cement instead of solder are also being tried, as well as complete cans of organic and plastic materials, and of heavy aluminum foil.

Sketch shows schematic arrangement of two-bend processing scale breaker.



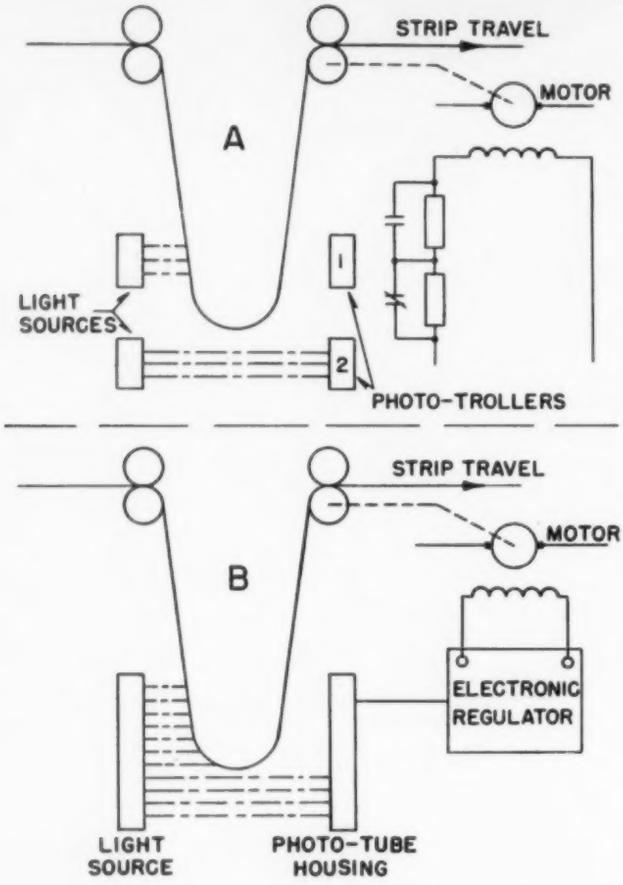
There are now about thirty electrolytic tinning lines in the United States with an annual capacity of 3,500,000 tons of electrolytic tin plate of the 0.5 lb grade. There are five lines outside the country and three others being planned. Of the thirty electrolytic lines in this country, seventeen are of the acid type and thirteen are the alkaline type. The lines abroad are acid type. The electrolytic lines which are being used for differential coatings have an acid electrolyte and horizontal construction which permit depositing tin on one side of the strip at a time. Speeds run up to 2500 fpm. Plating section has 24 cells in two decks. Each cell can be operated independently and so can each plating deck.

The new No. 3 electrolytic tinning line at J & L's Aliquippa Works has a number of new features. Some sizes of strip will be processed through this line at speeds up to 2500 fpm. This unit has a radio frequency brightener. The plating generator is controlled by electronic regulators which regulate plating current automatically over the entire speed range of the line. The brightener or reflow zone is powered by an 1800-kw radio frequency generator. Tin is heated for reflow in less than a quarter of a second with 1800 kw, the active heating zone being only 5½ ft long and the power density is as high as 400 kw per lineal ft of tin plate. More than 200 motors are used in driving the line and line auxiliaries.

It has been found that tallow can be used as a substitute for palm oil in hot dip tinning. Mill tests which were made by one of the research agencies . . . that beef tallow is a satisfactory substitute; it is cheaper and can be tailor-made to various specifications. In addition, it is not necessary to dewater it, preheat it or dilute it with used oil. In a plant test embracing 17,000 base boxes of 1.25 lb coating, menders averaged under 1 per cent. The tin yield was normal. Average oil consumption was 0.22 lb of oil per base box produced, which compares with 0.3 lb of palm oil for the industry average.

Another improved stripping oil was developed for hot dip tin and terne plating for which advantages are claimed over palm oil such as less smoke, less odor, and less decomposition. Even after six months, original properties are the same. The oil is made by mixing a fatty glyceride with an ester.

In order to save the maximum amount of tin, it is necessary to be able to measure the tin coating to insure that it is sufficient and also that not too much is applied. One piece of equipment developed for this purpose has two X-ray tubes, one mounted above the test sheet and the other below. The strength of the reflected X-ray beams is measured by Geiger counters calibrated to give the coating thickness on each side. Coatings can be measured with an error of less than 1 per cent. The instrument works on the principal that the reflected X-rays are in inverse proportion to the thickness of the tin coating. A number of these units are now in operation.



Loop regulators help increase efficiency in finishing operations.

A bank of rotating steel brushes for descaling steel has been developed to the point where the action of the brushes is effective enough for many mill requirements. These brush units can handle strip speeds of 200 to 500 fpm and higher. Whether the method will be adopted depends on mill costs. Among the advantages are that the scale produced is valuable, and neutralization problems may be lessened because of reduced pickling. The scale is in powder form.

A refinement in strip pickling is the use of an acid-proof magnetic loop control which enables the strip to be run closed to the bottom of the tank. As a result, higher speeds can be used and a longer portion of the strip is under acid without lengthening the tank. One plant's output has been increased from 400 to 580 tons per turn. Eight such units have already been installed and a number are on order.

The new Fairless Works will have what is stated to be the largest continuous pickling, cleaning and electrolytic tinning line in the world. The unit will be able to strip clean at speeds up to 2000 fpm and the tinning line will use coils up to 15 ton. This plant will also have one of the largest acid neutralization units in the country with a capacity of 150,000 gal of pickle liquor per hr. Lime will be used as a neutralizer.

A new plating process saves nickel in pipe plating. The plated pipe can be heated, formed or reduced. The process is relatively simple. A long nickel anode is inserted into the center of the pipe and the pipe is then flooded with a plating solution, the pipe rotating while the plating solution is inside. Bond is exceptionally good. Plating thicknesses range from 0.007 to 0.030 in. for 20-ft pipes from 1½ to 20 in. in diameter.

Another new achievement in plating was the invention of a tarnish resistant electroplate which consists of 65 per cent tin and 35 per cent nickel. This is deposited in a bright condition which requires little or no polishing. This plating is deposited on steel with a copper undercoating or on brass, from a solution containing stannous chloride, nickel chloride and sodium and ammonium chlorides. The deposit is hard and lustrous, and coating thicknesses of 0.0005 to 0.001 in. are recommended.

Another new plating method is called periodic reverse current plating. This method enables the substitution of copper for a large part of the nickel normally used. An important feature is a periodic reversal of the current, which deposits metal on the surface to be plated and then takes some of it away. The resultant coating is smoother, brighter and has fewer flaws than non-reversing methods.

A shock resistant porcelain enamel coating has been developed which is a one coat white over ground coat method. This process should make porcelain enamel more competitive with other finishes. The material is very shock resistant and will stand drilling, punching, shearing, and sawing.

A new process in which copper is bonded to steel was demonstrated during the year. Up to the present time, copper has been bonded to wire and small rod, but it has been more difficult to bond copper with sheet steel. A new highly volatile liquid flux which vaporizes when used, forming a gas flux, is the secret of the process. The molten copper is cast directly on to the steel, and at the present time bi-metal slabs up to 3½ in. thick with 20 per cent copper and 80 per cent steel have been successfully hot rolled in sheet bar and commercially sized sheet and strip. These have been rolled down to sheets 30 in. wide, 16-gage by hot rolling and further reduced by cold rolling to 0.005 in. in thickness. One use of this material is 30 calibre bullet jackets.

Another method of surface coating steel was also advanced during the year. A liquid layer of the coating metal is placed in the ingot mold, and floats on the parent metal. The ingot is fed from the bottom and as the metal surface rises, the top coating metal freezes along the sides of the mold, providing a coating on these ingots. The secret of this procedure lies in careful control of the pouring rate and temperatures. Metals such as manganese, nickel, copper, chrome and vanadium can be used as coating metals. One of the best possibilities is an aluminum coating for steel.

FURNACES AND CONTROLS

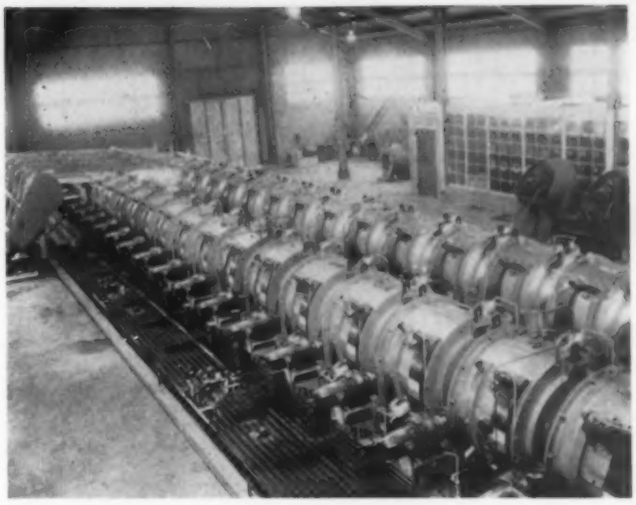
Control developments are making furnace operation more automatic. Automatic control in reversing systems on open hearth furnaces has resulted in smoother operation and several such units are in operation. In addition to controls which have been applied to the operation of the open hearth, a relatively new innovation is a viscosity control installed on the liquid fuel. It is important that viscosity be maintained con-

stant so that the flame characteristics will have relatively little variation due to this cause.

An interesting application at one plant has the gas dispatcher's panel board housing all the recording and integrating meters for the major fuel consumers. By means of these records, the dispatcher can tell what quantities of fuel are being used at the different plant locations and what gaseous fuel is being received from the coke works and other sources. He can thus efficiently allocate the available fuel to the various consumers.

There is still much question as to the merits of automatic roof temperature control in open hearths. The new open hearth plant at J & L is designed with pneumatic and electric control primarily, and will include roof temperature control, furnace pressure control, and automatic reversal based on time, temperature difference or maximum temperature. Furnace units will be equipped to use fuel oil, tar, coke oven gas and oxygen. Fuel flow, steam and oxygen pressure and flow, and gas pressure are all controlled. Viscosity control in this unit will be taken care of through individual reheaters for the liquid fuel.

Operating runs have been made on a number of open hearth furnaces in Great Britain in which roof pyrometers automatically control fuel flow. As a result, the operators can push their furnaces a little harder and at the same time make sure that temperatures do not increase to the point where permanent damage to the roof may result. Tests made on two shops showed the shop which had the automatic control to have an advantage of 180 tons per furnace week, of which about 100 tons is attributed to the control. One British operator reports a fuel saving of 2.1 gal per ton on an oil fired furnace.



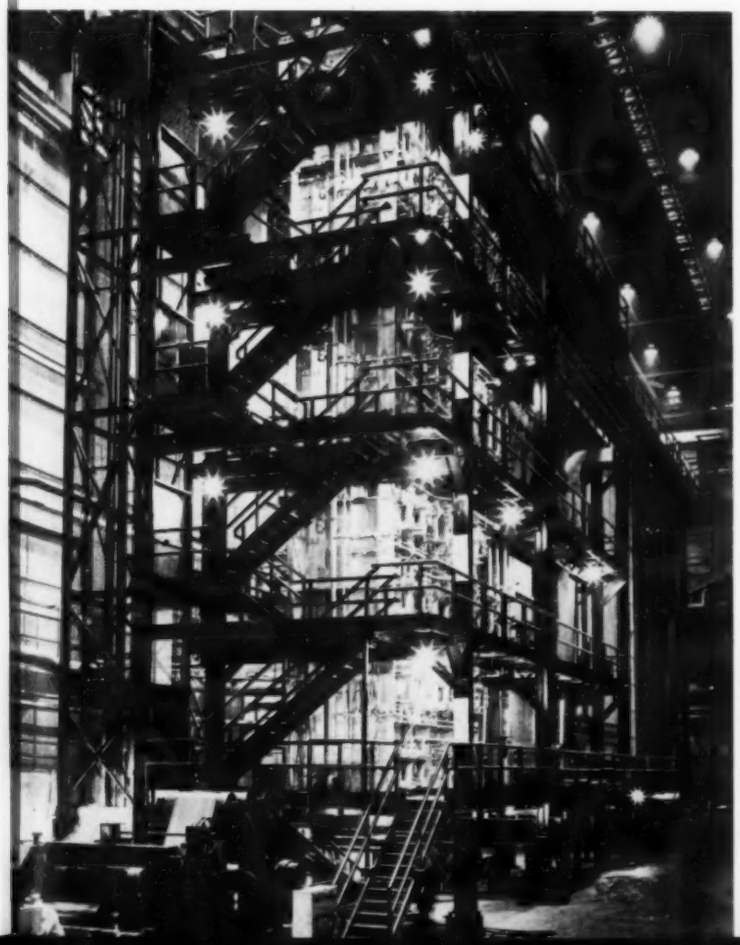
The double line high temperature — high speed heating installation at the Gary Works, National Tube Co. has a capacity of 40 tons per hour.

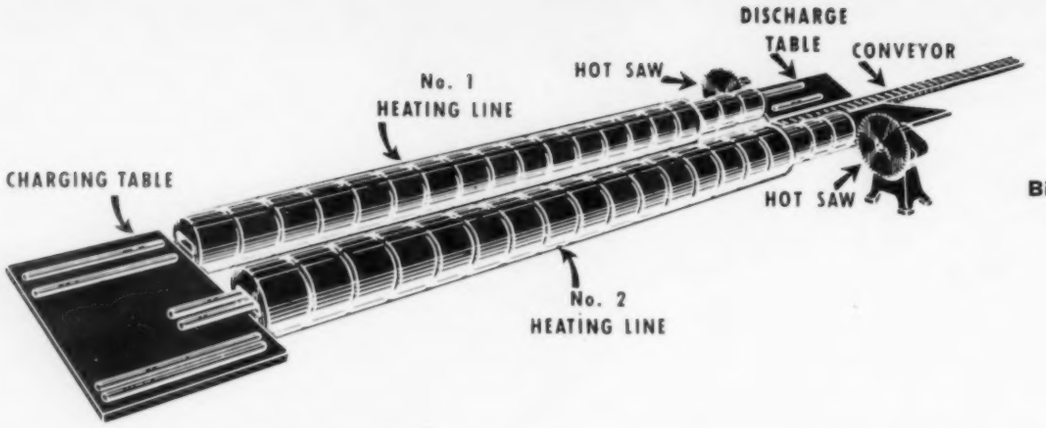
The effect of ingot track time on soaking pit heating has been the subject of a study in several plants. These studies indicate that good track time is the key to obtaining the best results in the soaking pit.

Continuous heat treatment of strip is meeting with increased favor as developments and studies unfold new possibilities. A new continuous annealing line was placed in operation in a Chicago district tin mill. This line continuously anneals up to 30 tons per hr of steel for tin and black plate products in widths of 18 to 37 in. The line has an annual capacity of 136,000 tons. A new building 336-ft long was required for the unit, which requires a ceiling height of 76 ft. The furnace section is equipped with a combination gas and electric heating unit. Coils first pass through a vertical alkaline cleaner line to remove oil or grease, then go into the furnace for annealing. The strip is surrounded by a protective inert gas atmosphere during both the heating and cooling cycles. During annealing, the strip temperature reaches 1300 F and moves at speeds up to 1000 fpm. The furnace consists of heating, holding and cooling sections, arranged for vertical strip passes with 48 ft between top and bottom roll centers. There is nearly 1800 ft of strip in the furnace at one time. The heating section is gas fired with radiant tube elements, while the holding section is heated electrically by resistance units. Air-tubes, water-jacket and air-blast cooling sections are combined to give the proper cooling rate. All furnace controls are automatic. The line drive uses a three-section adjustable voltage control scheme. Dual 90-ft storage loops are located between line sections.

Another continuous annealing line for tinplate sheets has been in operation in Canada for some time. Operating studies of the unit at this plant show that a unit which would anneal 5000 tons of strip steel per month has the following comparative figures for continuous and batch annealing respectively: floor space, 8700 sq ft versus 12,000 sq ft; capital investment, 1.40 versus 1.00; fuel consumption 500,000 Btu per ton versus 1,000,000 Btu per ton; atmosphere 822 cu ft per ton

The continuous gas-electric annealing furnace at the Gary Sheet and Tin Mill inaugurates a new phase of continuous heat treatment.





Billet heating line at Gary Works.

versus 1370 cu ft per ton; maintenance the same; annealing labor 0.39 man hours per ton versus 0.32 man hours per ton; cleaning, none for continuous annealing versus 0.25 man hours per ton for batch annealing. Continuous annealing requires fewer coils cooling.

Another unit was installed in a French mill for continuous heat treatment of aluminum alloy strip. Before this unit was built, it required very extensive testing and research to develop the required properties and behavior of the strip with various heat treating cycles. The test furnace was large enough to heat treat aluminum strip up to 56 in. wide and 0.010 to 0.080 in. thick. Speed varied up to 50 fpm. The line consisted of a welder, tension rolls, looping pit, tension rolls, and an induction heating unit rated at 1875 kva, 440-v, 60-cycle. After going down through the induction heater, the strip goes up through a holding furnace into a quench drier, tension roll, another looping pit, leveler, shears and recoiler.

A continuous furnace was announced which not only anneals bars, but restores the surface carbon. The furnace uses an atmosphere containing carbon which prevents carbon loss and adds or corrects surface decarburization from previous heat treatment operations.

High speed continuous heating methods which have been applied to pipe in the last few years seem to improve the physical properties. These units, which give high speed heating plus an improved cooling rate with a spray quench, produce full hardening without the use of alloy additions. Compared with the old batch method which required a total minimum time of about 19 hr, the continuous cycle used by the high speed continuous furnaces requires a total time of about 10 minutes. Stress relieving is not generally required.

The direct resistance method for heat treatment which has been used in steel wire has been expanded for use on narrow steel strip. This method gives higher physical properties than obtained by conventional methods. In a typical unit, which can heat treat 6000 lb of strip per hr, the strip is preheated to about 800 F, and then heated up to about 1600 F by passage of electric current through it. Upon reaching the desired temperature, the material is quenched in the bath at a temperature of about 900 F. One of the features of the method is a very high rate of heating, faster than that possible with furnace heating.

A high heat release oil burner was announced which will give well over 1,000,000 Btu per hr per cu ft of combustion space. This burner admits oil through a standard atomizing nozzle, the oil being premixed and vaporized with the combustion air before the combustion takes place, through the use of an annular chamber so designed that it gives recirculation of the gases from the combustion zone. Because of the operating characteristics of this burner, even less than theoretical air can be used without obtaining soot or carbon in the combustion gases.

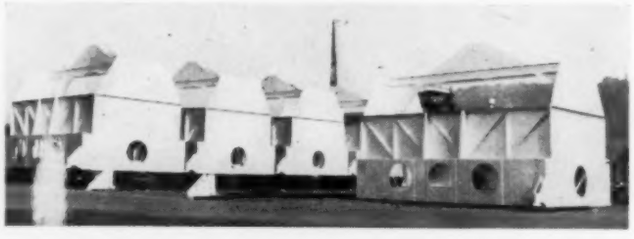
The development of a fused zirconium oxide was announced during the year, capable of withstanding temperatures up to 4600 F. The material can be used for furnace linings where high temperatures are required for heating elements and for containers and conveyors in furnaces. The material has one unusual property in that it is a poor conductor of electricity at low temperatures, but is an excellent electrical conductor at high temperatures.

Ceramics are also being used to coat parts such as components for jet engines. Material can also be applied to other items which must withstand high temperatures. Some of these can be sprayed like paint onto the part which they are to protect.

A continuous oxygen recorder has been developed which gives direct analysis for oxygen present in industrial gases. This instrument is based on the fact that of common gases, oxygen and nitric oxide are attracted by a magnetic field.

A new low cost gas producing plant went into operation in Rochester, N. Y., which can make gas ranging from 300 to 1050 Btu per cu ft. This is a demonstration unit, designed to produce more than 1,000,000 cu ft of city gas per day using gasoline, propane, butane, light

New type annealing covers provide more efficient and faster cooling through the use of forced air flow through outer and inner covers.



oil or natural gas as raw materials. It is estimated that the process can be used in units which will produce up to 12,000,000 cu ft of gas a day. One interesting feature is that the unit can be started cold and be operating at capacity in about one hour's time. Changes from one type of fuel to another can be made very easily.

Tests made by the Bureau of Mines have developed that gas can be obtained from lignite which is available throughout the Midwest, particularly in North Dakota. This gas can be used to produce synthetic fuels and some day may provide power for treating iron ore in Minnesota.

MATERIALS HANDLING

The increasing amount of steel which is being handled necessitated that maximum usage be made of all available material handling facilities and that more efficient material handling units be installed wherever possible. The industry is continuing its trend towards trucks for haulage purposes, and these are becoming major factors in the transportation of steel. One trend in truck usage during the year was an increase in the number of leased trucks which have been used.

An interesting event which could lead to some changes in operation occurred in Canada, where a 15-ton ingot was shipped by rail from Sidney, Nova Scotia, to Trenton, Nova Scotia, a distance of 200 miles while hot. Shipping temperature was 1770 F, and when it arrived at Trenton next morning the temperature was 1575 F. This low loss of heat was made possible because of vermiculite insulation in which the ingot was packed. Heat economies over previous reheating methods were important.

At the new Armco steel plant at Middletown, Ohio, where hydraulic elevators were installed to handle charging buggies, a number of other innovations in open hearth materials handling are included. One of these is a raw materials conveyor which moves from a track hopper up to the open hearth shop where the belt can drop the material into a number of storage bins on a level above the charging floor. Lift trucks are extensively used to carry brick and other refractory materials used in furnace rebuilds. The brick are palletized.

A development in lift trucks is a finger lift attachment which eliminates the need for the fork type lifting ram. With this attachment, crates can be lifted singly, in pairs, or in threes, directly from the production line and moved to storage and to box cars. The truck has a series of fingers, some of which engage cleats, and others are pushed back by the slats on the crate, thus eliminating the use of the pallet.

A diesel electric shuttle car was developed during the year which is the first such unit to be approved by the Bureau of Mines for use in non-coal mines. The Bureau of Mines also approved a diesel haulage locomotive for use in coal mines during the year.

A unique pipe line was designed which will be used to transport coal. A demonstration line has already been authorized for construction near Cadiz, Ohio. After the coal is mined, it is washed and crushed to fine size, then mixed with water to form a slurry which is pumped through the line by pumps specially developed for the purpose. It has been estimated that the cost of moving

New belt with teeth enables positive engagement, does not slip and permits close timing.

coal over a hundred mile journey through such a line would run between $1.30 and $1.91 a ton. This figure is based on a line moving about 5000 tons of coal per day. If the line capacity should be increased to some figure such as 36,000 tons per day, estimated cost for the movement as above would go down to between 40¢ and 95¢ a ton.

Although the Lake Erie-Ohio River belt project has been held up because of legislative action, a similar project is being considered to bypass the Sault Ste Marie Locks and the St. Mary's River. This has defense possibilities.

Overburden in ore pit on Mesabi Range is being handled by 36-in. conveyor which carries 1140 long tons at speeds of 500 fpm.

The development of electric strain gages has in turn led to developing their use in weighing applications. A number of electronic scales are on the market, and these have among other features the ability to record and imprint weight information, at points either at or remote from the actual weighing point.

MECHANCIAL

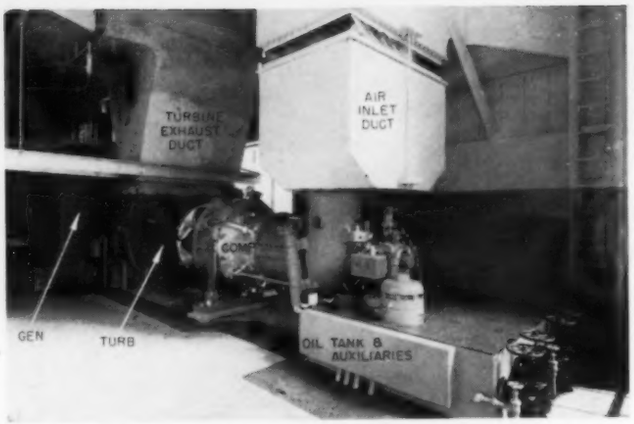
Power from atomic energy became a reality in 1951. Small amounts of electric power were produced from heat energy released in the operation of an experimental breeder reactor recently completed at the National Reactor Testing Station in Idaho by the Atomic Energy Commission. In trial runs on December 21 and 22, more than 100 kw of electric power were generated and used in the operation of pumps and other equipment. Heat energy was removed from the reactor by a liquid metal at a temperature high enough to generate steam to drive a turbine. The principal function of the breeder reactor is the long range goal of converting nonfissionable material into fissionable material more rapidly than nuclear fuel is consumed. An English unit is also apparently in operation.

Trends in ordinary power generation were toward larger units and gas turbines. The gas turbine units are meeting increased acceptance and a 15,000-kw machine was ordered during the year. The unit consists of a gas turbine driving a hydrogen-cooled generator. The gas turbine has both a high and low pressure turbine driving both high and low pressure compressors respectively, and the high pressure turbine is also connected to drive the generator. Intercoolers are used to reduce the temperature of the compressed air between stages of compression and a regenerator is used to reduce fuel consumption by applying exhaust gas heat to the air before it enters the combustor. These units operate at 1350 F. Turbine speed is 3600 rpm.

Another unit is a 5000-kw compound cycle, two shaft machine with regenerators to recover heat in the gas turbine exhaust, and with intercooling between stages of compression. This unit has a thermal efficiency of about 28 per cent, and can burn either natural gas, bunker C oil or diesel oil, but requires shutdown to change from gas to oil or vice versa. Cooling water required by these units is about one-fifth that required for the same size steam station and about two-thirds that required for a diesel station. Controls have also been developed which provide for semi-automatic starting and stopping, for speed and load control, and for protection of the unit under abnormal operating conditions.

In power stations, the trend toward adoption of reheat is very marked, and about 70 per cent of utility business are reheat installations. Since the end of the war, 116 reheat units with 12,102,500 kw capacity have been installed. The average size of these units is 100,000 kw although many are smaller, down to 50,000 kw.

Although the coal rate has gone down from 3 lb per kwhr in 1920 to about 1.19 lb per kwhr in 1950 (with lows of about 0.75 lb per kwhr), most of the gains in efficiency took place in the earlier part of this period. Since 1942, improvement in the national coal rate has been only 0.08 lb per kwhr. According to the Federal Power Commission, the ten most efficient steam plants in the United States ranged from about 10,437 to 11,442



The 3500-kw gas turbine generator unit shown is installed in a power station.

Btu per kwhr. Much improvement is still possible, when it is taken into account that the Sporn station has an approximate rate of 9400 Btu per kwhr and the new 1100 F reheat Kearny Station is estimated at 9000 Btu per kwhr.

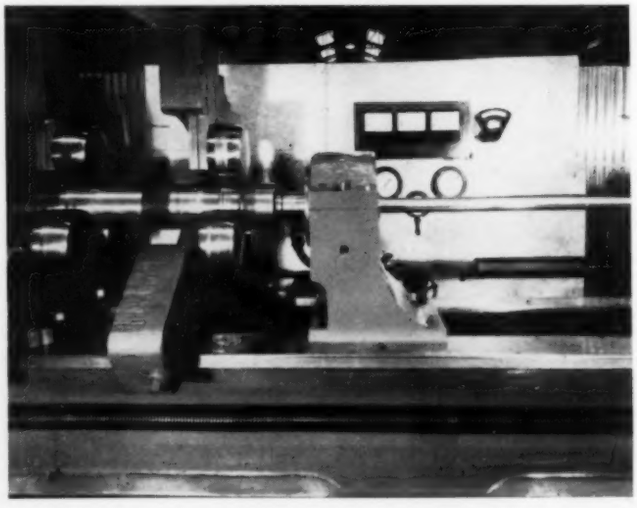
A new 60,000-kw turbogenerator installed in a Chicago district steel plant is said to be the largest ever built for industrial power production. The unit is supplied by a boiler furnishing steam at a rate of 650,000 lb per hr, the largest boiler ever designed to operate on blast furnace gas. It uses about 140,000 cfm of gas at full operation.

The largest 3600-rpm steam turbine to be built is under construction. This is a 185,000-kw tandem compound single shaft unit. Initial steam pressure will be 2350 psi and 1100 F with reheat to 1050 F. Shipment of this unit will not take place until 1954.

Under construction also are two 145,000-kw turbines which will use steam at 1100 F and 2300 psig. These are 3600-rpm, tandem, compound, triple flow generators. Efficiency should be good, as similar high temperature turbines in operation at 1050 F use only about $\frac{3}{4}$ lb of coal per kwhr.

Recent operating results on new mercury plants emphasize the economy of the mercury cycle. In general,

Trepanning lathe offers machining and material economies.



this type of plant seems to be most advantageous in applications as follows: complete condensing plants where only electrical power is produced in capacities of 12,500 to 130,000-kw; topping plants for topping existing steam generating units; rehabilitation of otherwise obsolete steam generating plants where inefficient steam boilers require replacement; or where it is desired to increase overall power plant efficiency to a maximum.

One of the large coal companies is building a million dollar plant in the Pittsburgh area which will be used for coal carbonization. Its purposes are to investigate the possibilities of cutting costs and improving usefulness of coal as a boiler fuel, increase the yield of coal chemicals, and produce synthetic liquid fuels from coal. This pilot plant will be built primarily to work out detailed costs and design data. The process itself is practical and has been proved by many extensive and detailed research tests.

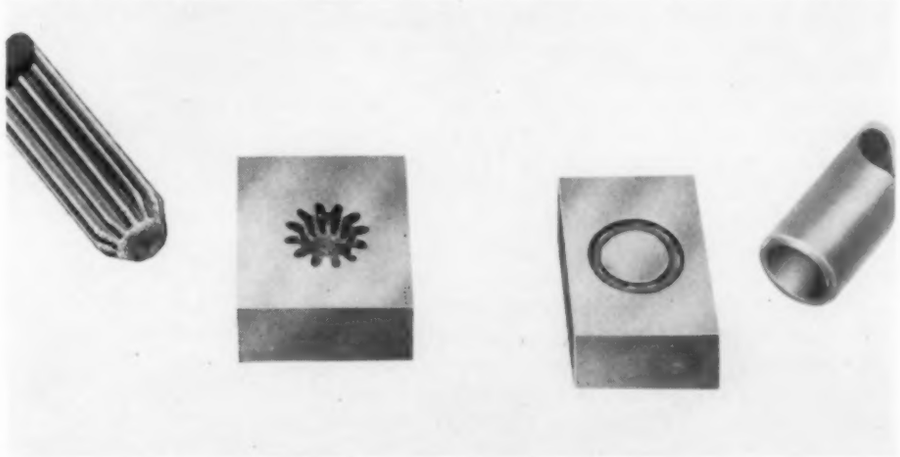
A new development which may help maintenance is a unit which prevents scale formation in water lines and boilers. This unit consists of a short piece of pipe which is spliced into the incoming water line and hooked to a control unit which sets up an electric field in the pipe.

process is particularly applicable to making holes of odd shapes and making holes which go only part of the way through the work. Tolerances within 0.0005 in. are claimed.

In another type of machine recently developed, abrasive particles and ultrasonic vibrations are used to cut complicated shapes in hard materials which are ordinarily difficult to machine. The abrasive compound is recirculated through the machine. Such materials as glass, porcelain, ceramics, etc. can be machined by the process.

In more conventional machining operations an entirely new material for cutting tools has been developed and will shortly be in production. This is a carbide produced from powdered metals which contains about 70 per cent chrome and is thus a chrome carbide. It eliminates the use of tungsten and cobalt which are both costly and scarce.

Full advantage of carbide tools is just being taken by the industry in new machine tool design. Because of these materials, faster machine tools can be developed than present units, with resultant increased production. Tests have been made which show that these cutting



New machining method which uses a spark erosion principle enables formation of many complicated cuts and shapes, even in very hard materials.

Particles and salts which form scale pick up an electric charge and become repellent to the boiler tubes and walls on which they would ordinarily be deposited. Operation and maintenance cost of this is low.

At the Fairless Works, about 230,000,000 gallons of water will be circulated through the mill each day. This water will be returned to the Delaware river in a continuous recirculating process. The plant will also use 15,000,000 gallons of underground water which will also be discharged into the river. Water treatment here in general includes pretreating the river water to improve it before use in the plant and treating it after use for discharge to the river.

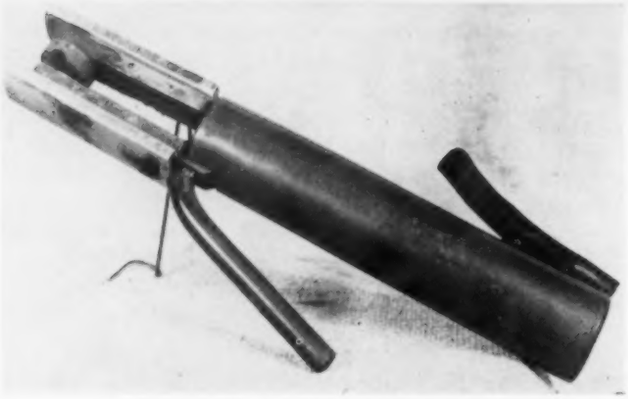
A water conditioning process using a synthetic resin has been developed which can produce an effluent with zero hardness, low solids, low alkalinity silica and carbon dioxide. Only salt and lime are needed for the operation.

An entirely new type of machining operation was put on the market in 1951 which offers some unusual features. The behavior of this machining operation is unique, as there is no physical contact between the tool and the work; the tool does not cut as in the usual methods, nor is the metal melted as in electrical arc methods. A spark is formed between tool and work and the spark seems to erode material out of the work. The

tools can move through steel at speeds up to 1400 fpm or better. The main requirement is that machines must be available which can supply the required speed and feed combination. Strangely enough, a milling cutter, for example, operated successfully at 1435 fpm with 0.020 in. feed per tooth, but when the feed was reduced to 0.0002 in., the tool became too hot to touch. As the feed was increased, the cutting tool operated much better.

Part of the betterment in machine tool production is due to a new concept that metal machining or machinability is tied in with the metal microstructure. Since the microstructure can be changed by heat treating, machine tool efficiency and work can be decreased by heat treating the material to give the microstructure, which results in best cutting operations.

The use of tungsten carbide in rough machining is a relatively recent development in this country although it has been used for some time for finished machining. To obtain the most efficient operation, it is necessary to see to it that a lathe, for example, is operated at the required spindle speed in terms of the diameter of the work piece. A new control which has been developed will maintain the proper surface speed. Such units have



Arc-air torch can be used for gouging and cutting.

been very helpful in modifying machine tools for tungsten carbide use.

Tracer control using photoelectric cells is being used for automatic contouring on vertical milling machines.

A new trepanning lathe was shown during the year, which not only saves time, but the solid core which results represents savings in costly steels and may often be used for other purposes.

Another new development is electroforming, which consists of nothing other than electroplating onto surfaces of molds and mandrels. These are later withdrawn, leaving a shell of the material that reproduces the original shape. When high speed deposition is used, metal can be built up in fairly short time. This method is best applied to jobs where unusual contours are to be made, when sections are thin, tolerances are close and surface smoothness requirements are high.

A twin development in increasing tool life was announced in December. This development includes a method by which high speed jets of oil are directed from below the cutting tool onto the tool during the cutting operation. The oil streams pass through the space between the work and side relief face of tool, and are aimed at the line of contact between the work and the cutting edge. This oil is caught between the chip and the tool.

A gasoline oxygen torch was developed during the year.

Thus the tool is efficiently lubricated and heat transfer is greatly improved. A second development which makes this possible is the special oil which is used in the procedure. The oil is applied through a small orifice at 400 psi. Units will be available by the middle of 1952 Test results using the method show greatly improved surface finish. As an example, surface roughness has been reduced from 200 to 60 microinches rms. Tool life on the other hand has been increased from 300 to 1200 per cent. Higher machining speeds are possible.

A newly developed cutting torch which will burn gasoline and oxygen was announced during the year. It is said that the unit has many advantages over the oxyacetylene type torch, and it is also claimed that it will give savings up to 30 per cent for operations as cutting, scarfing, etc. Fundamentally, the torch operates in the same manner as the acetylene torch in that it burns liquid gasoline and oxygen which is vaporized at the torch tip by the heat of the flame.

Another new torch developed during the year is a combination arc and air torch. This combines in one unit a carbon arc and an air blast. The unit has a $\frac{3}{8}$ by 12-in. carbon electrode and uses a 300 to 400 amp d-c welding machine plus compressed air. Fast cutting rates can be obtained and grooves $\frac{3}{8}$ in. wide to 2 ft long can be cut in one minute. The unit can save 75 per cent of the time over that by ordinary chipping.

A new method was developed during the year which will solder glass to metal in a process in which the bond is stronger than the glass itself. Both the glass and the metal are painted with a thin layer of titanium hydride, solder is placed on both areas and the two materials are placed together and heated under a vacuum.

Another new method will bond rubber to metal. In the process, the rubber is treated first with acid and then painted with a thin coat of a liquid resin. The liquid is also applied to the metal surface and the two materials are clamped together under pressure and heated at about 200 F for 20 minutes.

A new fireproof paint with a base of titanium tetrachloride offers many possible applications, but there are some problems yet in getting satisfactory adherence to metal.

Successful methods of casting certain types of rocks such as basalt have been put into operation in Europe. The method is quite similar to casting of iron. Possible products are drain pipes and other pipe-line accessories.

Nodular iron has taken extensive hold throughout the foundry industry. One large producer has practically shifted over to the material.

One interesting development during the year was in the field of cooling. Studies made on hot locations in plants have shown that in many cases air conditioning or fans may be one of the most inefficient ways of making the operator comfortable. Where the primary heat is due to radiation, adequate shields or reflectors will provide the required cooling much more easily and efficiently. The cooling offered by conditioning systems and fans is a very efficient answer for convectional heat, but has relatively little value against radiant heat. In recognition of this principle, different types of highly reflective screens have been developed, sometimes backed by such materials as gypsum board. In addition to reflecting screens, absorption screens can also be used or even heat exchanging screens which may be made of

steel and which are water cooled. This is a particularly important problem in the steel plant where much heat comes from such sources as red hot sheet, plate and billets.

Test work on an experimental diesel engine during the year indicates that the diesel may still be a long way from its ultimate limit. It appears that the true high speed diesel with much increased flexibility and reduced size will be a good future probability.

In the lubrication field, tungsten carbide bearings offer extremely good possibilities on high speed machines. Test bearings have been made with a dimensional accuracy of one-millionth of an inch and a surface finish of 1 to 3 microinches. From tests at different speeds, loading and lubrication conditions, much data have been accumulated. One bearing, for example, ran 200 hours at 450 psi with no size changes which could be measurable to 1/100,000 in. Such units will operate on a high speed, high load and high temperature condition where ordinary bearings will fail. A number of critical bearing problems may be solved in the future by the use of these carbide metals, which have been operated at speeds up to 30,000 rpm and with loads up to 2000 psi.

In tests run by the Bureau of Standards on a number of special lubricants, it was shown that molybdenum disulphide gave the lowest static friction. This was followed in order by lubricating grease, by molybdenum disulphide, and by a fluorinated hydrocarbon with a graphite additive.

Production tests on a number of waxes indicate that they may find wide usage as a metal working lubricant. The use of special blends of waxes has resulted in drawing stainless steel far beyond that obtained by the use of conventional lubricants.

A new proprietary material was developed which is an alloy of metals and chemicals produced by bringing together molten metals plus a wet chemical mass. Once the original metal is made, it can be melted or remelted as ordinary metals. However, the molecular structure of the ingredients is changed. Possible applications are dry bearings which will require no lubricants.

One company started large scale production of a combination rubber and fabric belt with teeth. This is considered an outstanding advance in the power transmission field, as the belt allows no slip and gives split second timing. Speeds up to 16,000 fpm can be obtained. The belt requires no lubrication, although oil will do it no harm.

A plating method has been developed for the primary object of rebuilding worn sliding parts of industrial machinery. The process consists of putting the worn parts into a plating bath and replating the material with electrolytic iron. Any strength and any thickness can be built up by the method. The advantage of the process is that more than three times as much material can be deposited as can be done with a chrome coating. Fundamental in the process is the exact care and control which is used in the plating operation.

Metal laundries are an interesting British development which give economy in rehabilitating equipment. A number of plants have been set up throughout Great Britain to which rusted and corroded material is sent for reclamation. Here the metal parts go through various baths, one to remove grease, another to take off rust and another to impart polish. Finally, the material comes out looking almost like new.

Corn cob grits have been used in a very effective,

Radiation shielding using corrugated aluminum, protects rolling mill pulpit.

safe way for cleaning electrical and other equipment. The grits are used in an air blast similar to sand blasting, and give an excellent and fast cleaning job. In addition, it is a safer method because toxic inflammable fumes are not present.

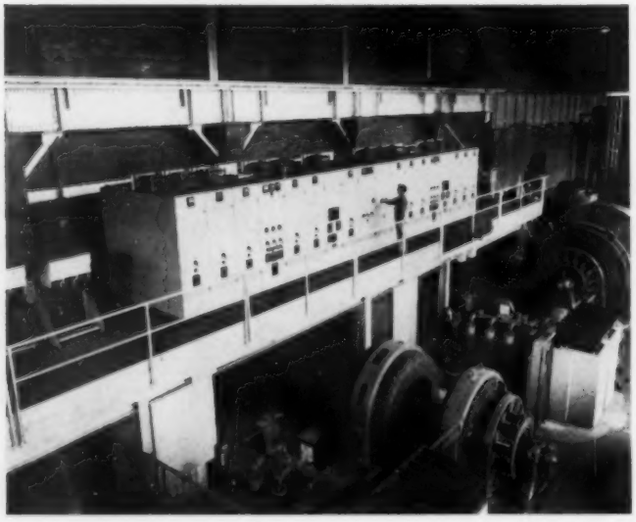
ELECTRICAL

From 1939 to 1950, American industrial plants increased its use of electric power from 81,200,000,000 to 189,700,000,000 kwhr, or 134 per cent. In the same period the industrial production index went up 83 per cent which means that industry is using a greater percentage of electrical energy per unit of production. Industry in general is depending more and more on purchased power, generating 37.5 per cent of its own power in 1939 and only 27.5 per cent in 1950. In 1950 industry generated only about 15 per cent of *all* power, both industrial and domestic. Electric power used in 1951 for all purposes totaled over 426,000,000,000 kwhr, of which about 370,000,000 kwhr was generated by electric utilities.

Additional facilities for the production of electric power are under way. The present target is 97,000,000 kw by the end of 1953 for an estimated peak load of 89,000,000 kw. This is an increase of about 40 per cent in three years. The capacity at the end of 1951 was over 75,000,000 kw, and peak load was about 62,000,000 kw, although demand was not evenly spread out in accordance with generating capacity. During 1951, the electrical industry added about 7,000,000 kw of generating capacity, at an investment cost of about $3,000,000,000. Thus, generating capacity was increased about 10 per cent over 1950, a record increase for one year. In spite of this expansion, demand has exceeded supply in certain areas, such as the Pacific Northwest and also the Pittsburgh area.

The increase in generating capacity has also required increases in transmission. Developments in the transmission field show a continued trend toward increased kw loadings per circuit, reduced line insulation and reduced losses because of larger conductors, better transformers and kvar controls. In the future it is expected that the industry will use larger transformers and generators, better relaying, increased interconnection of systems and higher interrupting capacity breakers.

Blooming mill motor room at the Otis Works has some of the largest metal enclosed drawn out switchgear ever installed for heavy duty d-c service.



A new generator design was announced during the year which permits the generation of more power while using less copper and steel. Sizes are decreased with resultant advantages. The key to the new design is the use of hollow conductors through which cooling hydrogen is passed. In this way the gas picks up the heat directly from the copper conductors instead of waiting for it to be conducted through the electrical insulation. Allowable ratings, because of this design, can be increased from 50 to 100 per cent, and it appears that ratings up to 275,000 kw are possible for 3600-rpm single unit generators. The design is particularly applicable to units of 90,000-kw and up.

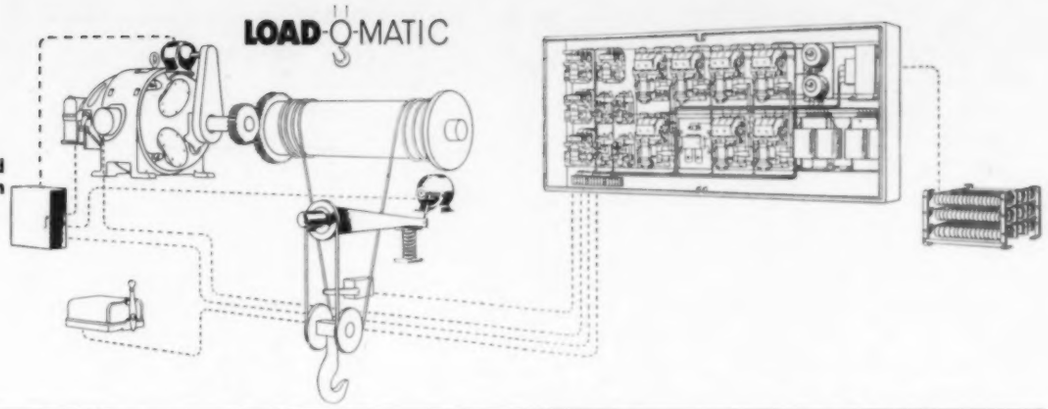
Commutator segments are being produced from copper or copper oxide powder. The powder is mixed with a small percentage of graphite and the resultant product sintered. These are die sized to the proper size for use in the commutator. Wearing qualities are bettered by the lubricating properties of the graphite incorporated in the metal.

The Association of Iron and Steel Engineers developed standards during the year for carbon brushes. The adoption of these standards should result in many economies in maintenance and operation of electric motors.

In a new booming mill drive in the Pittsburgh district, a 46-in. high-lift mill, many new design features are applied. The main reversing drive of this mill will have 10,000 hp, delivered by twin 5000-hp, d-c reversing motors coupled directly to the upper and lower rolls to give speed ranges from 40 to 100 rpm. D-c adjustable voltage power is supplied by four 2500-kw generators on a flywheel motor-generator set. An 8000-hp wound rotor motor is used to drive the d-c generators, and this is controlled by a new type liquid slip regulator. Rotating regulators are used to provide load balance between the twin motors of the main drive, and between the four 2500-kw generators. About 6000 hp are applied on the mill auxiliaries. Power supply is 13,800-v, 3-phase, 60-cycles. Total cost of electrical equipment for this unit is about $2,500,000.

The famous blooming mill of the Jones & Laughlin Steel Corp. at Aliquippa, which set the world's record for bloom production of 183,728 tons in March, 1949, will have the steam engine which has been driving this mill replaced by a 12,000-hp d-c drive. Main motors will be twin drive, 6000-hp, double armature units. One requirement was that the motors were to be designed to reverse from base speed to base speed in about one second, as against the two seconds usual for mills of this type.

A twin-tandem motor drive for a two-stand temper mill was built for Jones & Laughlin Steel Corp. in which the 600-hp, 1150/1500-rpm motors, each consisting of two 300-hp armatures, provide independent drives for the upper and lower work rolls of Stand 2. Drive is direct to the work rolls through spindles having universal joints at both ends; thus the shaft spacing must be approximately the same as the diameter of the work roll. To meet the 18½-in. shaft center-to-center distance, a special six-pole electrical design using an unusually small diameter armature with long stacking was



Crane control illustrated is regulated by load on hook.

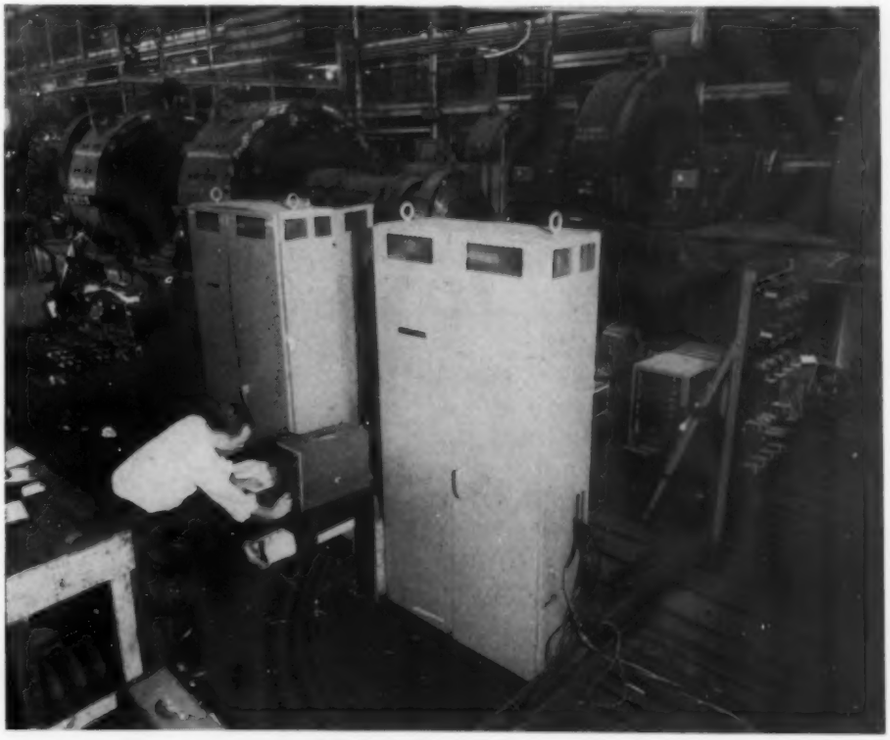
used. Short pole pieces with field coils wound directly on the poles, together with the thinner frame permitted by the six-pole design, made possible a frame of minimum diameter.

Rectifiers are being applied more and more on hot strip mills. The largest single rectifier rolling mill application is for the 80-in. hot strip mill which will go in at the Fairless Works of the United States Steel Co. This mill will have six 4000-kw units to provide 24,000 kw for six finishing stand motors. This power comes through three separate bus sections, with two 4000-kw rectifiers supplying each section.

Rectifiers have been found economical on the hot strip mills because the latter operated at fairly steady voltage for appreciable periods of time. The variation in loads on cold mills and on reversing mills has held back its usage on such units because the rectifier is essentially a one-way street. Since the motor-generator can readily absorb energy which is pumped back into the power system, it becomes economical in comparison with the rectifier on variable speed and reversing mills. In Europe, however, rectifiers have been applied to several reversing cold strip mills and to reversing blooming and slabbing mills. This has been done in two ways. In one scheme, two sets of rectifiers were used, with the group in operation depending on the direction of the current; in other words, one group operates during acceleration cycles, and the other group operates during deceleration cycles. Another method has been through the use of a reversing switch.

A new magnetic amplifier regulator was tested during the year for steel mill service. This was done under simulated operating conditions on a 4000-hp, double armature motor which is to be used on a 66-in. tandem cold reduction mill. The magnetic amplifier gives a fairly simple regulating system, and it is believed that the unit will require much less maintenance than present schemes. One reason for this is that it is a static device which has no bearings or brushes to maintain. The device is not new, but the availability of better core materials and dry type rectifiers gives greater flexibility of operation, more dependable performance and higher amplification. These units will probably take over many industrial control functions. One application is for phase shift control on rectifiers.

A new device which has a number of electrical control



Magnetic amplifier regulators have been developed which will supplement and in some cases replace equipment using electronic and rotating regulators.

possibilities works by reacting to very slight changes in the voltage of alternating current. The principle of the new unit involves a resonant electrical circuit somewhat similar to the constant voltage transformer. In one application, this control is used in combination with a power relay and resistor as a switching device. The electrical circuit consists of three windings: a primary winding, a secondary winding and a relay coil winding in series with a capacitor which comprises the resonant circuit. The magnetic circuit consists of a closed core provided with a magnetic shunt. Among initial uses proposed for the device are automatic operation of auxiliary power equipment in isolated stations, protection of motors and other electrical equipment against excessive high or low voltage, step by step voltage regulation, and control of selective voltage circuits from a single variable voltage source.

Four of the largest transformers ever to be built were started during the year. Rated at 190,000-kva each, they are scheduled for a public utility. These units are three-phase, 60-cycle, 138,000/15,000 volts.

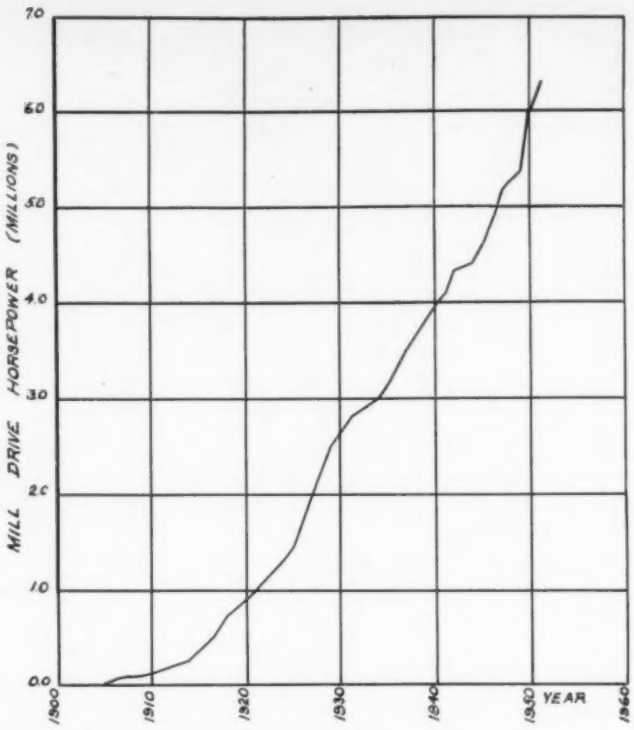
Air-blast circuit breakers for arc-furnace applications in the 25 to 34.5 kv ratings were made available to eliminate the problem of oil contamination always present with oil interrupters. The solenoid operating mechanism in the design fulfills the demand for a breaker with long mechanical life under the stress of continuous repetitive service.

High voltage air contactors are now available with an interrupting capacity up to 50,000 kva. Contactors have a 25,000-amp, through-current rating at 30 cycles, as well as 35,000 amp, one-cycle rating. Thus the contactor can be used as a motor starter on systems up to 50,000-kva without additional back-up protection, and with back-up protection, can be used like most starters.

An a-c crane hoist control announced during the year incorporates a load detector into the hoist system. The mechanism is arranged to produce a mechanical deflection proportional to the load on the hook; this mechanical deflection in turn operates a magnetic inductor which produces a signal current proportional to the load. The signal current operates through main circuit saturable reactors to control the power delivered to the motor. The load detector thus divorces torque from speed, and permits coordination of speed and loads to suit the particular requirements of the crane. Extremely close control can be obtained without jogging, inching or retardation. The control can do this equally well for empty hook, light or maximum loads. This is accomplished without the use of electrical or mechanical load brakes.

A new line of type-M, heavy-duty, d-c contactors designed specifically for service in steel mill and crane applications was announced during the year. The contactors feature unit construction and are available in National Electrical Manufacturers Association ratings. Silicone-impregnated high-temperature coils permit lower coil inductance and faster operation.

A serviceable silver contact surface for aluminum bus bars, equal to that of copper with silver contacts, was developed during the year. Factory equipment now plates the silver on aluminum to any desired thickness. The silver is so thoroughly bonded that the contacts



The cumulative curve of main drive motors over 300 hp shows a total to January 1, 1952 of 6,328,090 hp. Two hundred and four motors (339,200 hp) were added in 1951, or about two-thirds the total added in 1950.

meet all requirements for contact stability and resistance to corrosion, at all operating temperatures.

An interesting development is that of the thermally sensitive resistors. These are metal ceramics which act in exactly the opposite manner to conventional metals with regard to variations in electrical conductivity with temperature changes, as the electrical resistance decreases very sharply with increase in temperature. Resistors will find uses as the sensitive elements in flow meters linked with level indicators, and control timers and relays, pushing devices and other types of controls.

A new battery was developed during the year, primarily for the automotive field. Four new developments were combined to add to the life of the new battery. Silvium, an unusual lead-silver alloy, is used for grid. Grid framework, filled with a new lead composition active material in paste form, is used for the plates. A milder electrolyte is used to react on the active material, and the negative and positive plates in the battery are insulated from one another by a new plastic which is more efficient than wood or porous rubber.

In order to reduce underground corrosion of electric lead-sheathed cable, steel piping and structural steel, the new Morrisville plant of U. S. Steel is using bars of magnesium metal which will be buried adjacent to the items which they are to protect. This form of cathodic protection was designed after extensive work and measurements of soil and water samples from the work site.

Summarizing, 1951 was one of the most active years in the history of the steel industry. The additional horsepower supplied by the main roll drives furnished during 1951 is the second largest in history totalling 204 motors with 339,200 hp.

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1951

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
1	②300	300/900	230	d-c	Direct	80-in. Hot mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
2	350	575	230	d-c	Direct	160-in. Reversing plate mill	Societe Des Acieries De Longwy	France	Westinghouse
3	350	400/1200	250	d-c	Geared	Cold mill reel	Dow Chemical Co.	Midland, Mich.	Westinghouse
4	350	300/900	230	d-c	Direct	Reversing hot strip coiler	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse
5	350	375	230	d-c	Geared	Slabbing mill shear	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse
6	350	375	230	d-c	Geared	Slabbing mill shear	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse
7	350	500/1000	600	d-c	Geared	66-in. Reversing cold strip	United Iron & Steel	Austria	General Electric
8	400	300/1200	250	d-c	Geared	Temper pass mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
9	†400	428	380	50	Direct	2-High cold mill	Madeco Manufacturas De Cobre	Chile	Westinghouse
10	400	400/1200	600	d-c	Geared	12-in. Reversing cold strip mill	Crucible Steel Co.	Harrison, N. J.	General Electric
11	400	350/1050	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
12	400	350/1050	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
13	400	350/1050	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
14	400	200/400	600	d-c	Geared	Merchant and rod mill	Carpenter Steel Co.	Reading, Pa.	General Electric
15	400	500/1000	250	d-c	Geared	48-in. Skin pass mill	Hojalata y Lamina S. A.	Mexico	General Electric
16	480	272/680	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
17	480	410/1020	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
18	480	465/1160	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
19	480	520/1300	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
20	480	560/1400	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
21	500	350/700	250	d-c	Geared	66-in. Single stand, 2-high temper pass mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
22	500	690/1380	600	d-c	Geared	Sendzimir mill	Sharon Steel Corp.	Sharon, Pa.	Westinghouse
23	②500	250/850	600	d-c	Geared	Sendzimir mill	Sharon Steel Corp.	Sharon, Pa.	Westinghouse
24	②500	250/850	600	d-c	Geared	Sendzimir mill	Sharon Steel Corp.	Sharon, Pa.	Westinghouse
25	500	450/900	600	d-c	Geared	Temper pass mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
26	500	450/900	600	d-c	Geared	Temper pass mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
27	500	575/1150	250	d-c	Direct	4-High cold mill	Laminacao National de Metais	Brazil	Westinghouse
28	†500	720	3800	60	Direct	Slabbing mill	Aluminum Co. of Canada	Canada	Westinghouse
29	500	575/1150	600	d-c	Geared	84-in. Sheet temper mill	Geneva Steel Co.	Provo, Utah	General Electric
30	500	400/1200	600	d-c	Geared	48-in. Reversing cold strip mill	Hojalata y Lamina S. A.	Mexico	General Electric
31	500	400/1200	600	d-c	Geared	48-in. Reversing cold strip mill	Hojalata y Lamina S. A.	Mexico	General Electric
32	†500	1200	4160	60	Geared	Aluminum sheet mill	Hunter-Douglas	Oakland, Calif.	General Electric
33	500	125/500	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
34	500	125/500	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
35	500	125/500	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
36	*500	514	2300	60	Geared	Tube reeler	Republic Steel Corp.	So. Chicago, Ill.	General Electric
37	*500	514	2300	60	Geared	Tube reeler	Republic Steel Corp.	So. Chicago, Ill.	General Electric
38	*500	514	2300	60	Geared	Tube sizing mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
39	*500	514	2300	60	Geared	Tube reducing mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
40	*500	514	2300	60	Geared	Tube reeler	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
41	*500	514	2300	60	Geared	Tube reeler	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
42	*500	514	2300	60	Geared	Tube sizing mill	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
43	*500	514	2300	60	Geared	Tube reducing mill	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
44	†500	500	5000	50	Geared	80-in. Sheet temper mill	S.I.A.C.	Italy	General Electric
45	①500	450/900	600	d-c	Geared	66-in. Sheet temper mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
46	①500	450/900	600	d-c	Geared	66-in. Sheet temper mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
47	500	575/1280	600	d-c	Geared	Hot strip mill	Anaconda Copper Mining Co.	Kenosha, Wis.	Elliott Co.
48	600	300/600	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
49	600	300/600	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
50	600	300/600	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
51	600	300/600	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
52	600	400/800	600	d-c	Geared	Merchant, strip and rod mill	Carpenter Steel Co.	Reading, Pa.	General Electric
53	600	400/800	600	d-c	Geared	14-in. Hot strip mill	Carpenter Steel Co.	Reading, Pa.	General Electric
54	600	250/500	600	d-c	Geared	14-in. Hot strip mill	Carpenter Steel Co.	Reading, Pa.	General Electric
55	600	400/800	600	d-c	Geared	Merchant and rod mill	Carpenter Steel Co.	Reading, Pa.	General Electric
56	600	250/500	600	d-c	Geared	Merchant and rod mill	Carpenter Steel Co.	Reading, Pa.	General Electric
57	600	250/500	600	d-c	Geared	Merchant and rod mill	Carpenter Steel Co.	Reading, Pa.	General Electric
58	600	250/875	750	d-c	Geared	Skin pass mill	Fiat Sezione	Italy	General Electric
59	600	300/900	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
60	600	300/900	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
61	600	150/540	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
62	600	150/540	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
63	600	200/720	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
64	600	200/720	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
65	600	200/720	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
66	②600	300/900	600	d-c	Geared	Sendzimir cold strip mill	Wallingford Steel Co.	Wallingford, Conn.	General Electric
67	②600	300/900	600	d-c	Geared	Sendzimir cold strip mill	Wallingford Steel Co.	Wallingford, Conn.	General Electric
68	600	200/720	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
69	600	200/720	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
70	600	400/1050	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
71	600	400/1050	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
72	600	150/450	450	d-c	Geared	66-in. Reversing hot strip edger	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
73	600	225/350	600	d-c	Geared	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
74	600	250/500	230	d-c	Direct	Reversing hot strip mill coiler	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse
75	600	250/500	230	d-c	Direct	Reversing hot strip mill coiler	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse
76	†600	500	380	50	Direct	3-high Hot mill	Madeco Manufacturas de Cobre	Chile	Westinghouse
77	700	200/680	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
78	700	250/825	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
79	700	300/900	600	d-c	Geared	10-in. Bar mill	United States Steel Co.	Morrisville, Pa.	General Electric
80	700	170/340	600	d-c	Geared	Rod mill	Crucible Steel Co.	Midland, Pa.	General Electric
81	700	300/600	600	d-c	Geared	Sendzimir cold strip mill	Wallingford Steel Co.	Wallingford, Conn.	General Electric
82	*750	300	4000	50	Geared	Cold mill	Corporacion de Fomento de la Produccion	Chile	General Electric
83	*800	360	2300	60	Geared	45-in. Slab mill edger	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
84	800	400/800	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
85	800	400/800	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
86	800	400/800	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
87	800	400/800	600	d-c	Geared	14-in. Hot strip mill	Carpenter Steel Co.	Reading, Pa.	General Electric
88	800	400/800	600	d-c	Geared	14-in. Hot strip mill	Carpenter Steel Co.	Reading, Pa.	General Electric
89	800	200/400	600	d-c	Geared	14-in. Hot strip mill	Carpenter Steel Co.	Reading, Pa.	General Electric
90	800	200/600	700	d-c	Geared	29-in. Slabbing edger	Hojalata y Lamina, S. A.	Mexico	General Electric
91	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
92	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
93	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
94	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
95	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
96	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
97	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
98	800	350/875	600	d-c	Geared	Skelp mill	National Tube Co.	Morrisville, Pa.	General Electric
99	†800	400	2300	60	Geared	Scale breaker	Pittsburgh Steel Co.	Allenport, Pa.	General Electric

*Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double Armature

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

(CONTINUED)

Item	Horse-power	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
100	②800	100/430	750	d-c	Direct	56-in. Tandem cold strip mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
101	800	175/350	600	d-c	Geared	10-in. and 24-in. x 20-in. 4-high Reversing cold mill	Athenia Steel Division National Standard Co.	Clifton, N. J.	Elliott
102	800	224/560	600	d-c	Direct	24-stand Rod and merchant mill	Fiat Co.	Italy	Westinghouse
103	*800	360	2300	60	Geared	10-in. Rail rerolling mill	Pollack Steel Co.	Marion, Ohio	Westinghouse
104	900	300	600	d-c	Direct	Hot strip mill	Societe Italiana Accierie Cornigliano	Italy	Westinghouse
105	†900	750	440	50	Direct	Merchant bar mill	Aceros Ecatepec	Mexico	Westinghouse
106	*900	1000	440	50	Direct	Merchant bar mill	Aceros Ecatepec	Mexico	Westinghouse
107	900	500	600	d-c	Direct	80-in. Hot strip mill flying shear	Armco Steel Corp.	Ashland, Ky.	Westinghouse
108	*1000	514	2300	60	Geared	Billet mill	Laclede Steel Co.	Alton, Ill.	Westinghouse
109	1000	45/90	600	d-c	Direct	Blooming mill	Atomic Energy Commission	Fernald, Ohio	Westinghouse
110	1000	250/575	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
111	1000	250/1000	600	d-c	Geared	66-in. Reversing cold strip mill	United Iron and Steel	Austria	General Electric
112	1000	250/1000	600	d-c	Geared	66-in. Reversing cold strip mill	United Iron and Steel	Austria	General Electric
113	1000	500/1000	600	d-c	Geared	Aluminum cold strip mill	Aluminum Co. of America	Alcoa, Tenn.	General Electric
114	1000	500/1000	600	d-c	Direct	Aluminum cold strip mill	Aluminum Co. of America	Alcoa, Tenn.	General Electric
115	1000	0/250/720	700	d-c	Geared	36 and 54 x 90-in. 4-high Reversing edger	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
116	②1200	200/800	600	d-c	Geared	66-in. Sheet temper mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
117	②1200	300/1050	600	d-c	Geared	Temper pass mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
118	1250	60/180	600	d-c	Direct	20-in. Blooming mill	Carpenter Steel Co.	Reading, Pa.	General Electric
119	1250	300/500	750	d-c	Direct	Skin pass mill	Fiat Sezione	Italy	General Electric
120	*1250	240	2300	60	Geared	2-stand Blooming mill	Jessop Steel Co.	Washington, Pa.	General Electric
121	*1250	240	2300	60	Geared	4-stand Hot strip mill	Jessop Steel Co.	Washington, Pa.	General Electric
122	1250	400/800	600	d-c	Geared	4-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
123	1250	400/800	600	d-c	Geared	4-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
124	1250	400/800	600	d-c	Geared	4-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
125	1250	400/800	600	d-c	Geared	4-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
126	1500	200/500	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
127	1500	200/500	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
128	1500	350/700	600	d-c	Geared	48-in. Reversing cold strip mill	Hojalata y Lamina, S. A.	Mexico	General Electric
129	*1500	360	2300	60	Geared	Piercing mill	Ohio Seamless Tube Co.	Shelby, Ohio	General Electric
130	*1500	514	6600	60	Geared	Plug mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
131	1500	300/600	600	d-c	Geared	Assel mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
132	*1500	514	6600	60	Geared	Plug mill	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
133	1500	350/700	600	d-c	Geared	66-in. 3-stand Tandem sheet mill	Ford Motor Co.	Dearborn, Mich.	General Electric
134	1500	450/750	600	d-c	Geared	18-in. Breakdown mill	Connors Steel Co.	Birmingham, Ala.	Westinghouse
135	1500	400/800	600	d-c	Direct	Combination hot and cold mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
136	①1500	300/670	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
137	①1500	300/670	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
138	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
139	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
140	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
141	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
142	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
143	1750	300/600	600	d-c	Geared	6-stand Billet mill	United States Steel Co.	Morrisville, Pa.	Allis-Chalmers
144	1750	250/625	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
145	1750	250/625	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
146	1750	250/625	600	d-c	Geared	Merchant and skelp mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie	General Electric
147	2000	175/400	750	d-c	Direct	50-in. Tandem cold strip mill	National Steel Co. of Brazil	Brazil	General Electric
148	2000	250/465	240	d-c	Geared	Assel mill	Timken Roller Bearing Co.	Canton, Ohio	General Electric
149	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
150	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
151	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
152	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
153	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
154	①2250	200/450	750	d-c	Direct	66-in. 4-stand Tandem cold strip mill	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
155	2500	250/500	600	d-c	Direct	Cold mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
156	②2500	100/300	750	d-c	Direct	56-in. Tandem cold strip mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
157	2500	125/300	750	d-c	Geared	45-in. Slab mill edger	Lone Star Steel Co.	Lone Star, Texas	General Electric
158	2500	250/500	750	d-c	Geared	50-in. Hot strip mill	National Steel Co. of Brazil	Brazil	General Electric
159	2500	175/400	600	d-c	Geared	66-in. 3-stand Tandem sheet mill	Ford Motor Co.	Dearborn, Mich.	General Electric
160	3000	50/120	700	d-c	Direct	29-in. Slabbing mill	Hojalata y Lamina, S. A.	Mexico	General Electric
161	3000	70/175	700	d-c	Direct	48-in. Reversing hot strip mill	Hojalata y Lamina, S. A.	Mexico	General Electric
162	3000	175/370	600	d-c	Direct	66-in. Reversing cold strip mill	United Iron and Steel	Austria	General Electric
163	①3000	40/100	600	d-c	Direct	66-in. Reversing rougher	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
164	①3000	40/100	600	d-c	Direct	66-in. Reversing rougher	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
165	*3000	257	6600	60	Geared	Piercing mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
166	*3000	257	6600	60	Geared	Piercing mill	Republic Steel Corp.	So. Chicago, Ill.	General Electric
167	*3000	257	6600	60	Geared	Piercing mill	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
168	*3000	257	6600	60	Geared	Piercing mill	Colorado Fuel & Iron Corp.	Pueblo, Colo.	General Electric
169	①3500	40/80	750	d-c	Direct	45-in. Universal slab mill	Lone Star Steel Co.	Lone Star, Texas	General Electric
170	①3500	40/80	750	d-c	Direct	45-in. Universal slab mill	Lone Star Steel Co.	Lone Star, Texas	General Electric
171	3500	175/350	600	d-c	Geared	66-in. 3-stand Tandem sheet mill	Ford Motor Co.	Dearborn, Mich.	General Electric
172	②3500	200/500	750	d-c	Direct	56-in. Tandem cold strip mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
173	①3500	0/40/80	700	d-c	Direct	36-in. and 54 x 90-in. 4-high Reversing main drive	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
174	①3500	0/40/80	700	d-c	Direct	36-in. and 54 x 90-in. 4-high Reversing main drive	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
175	3500	514	11000	60	Geared		Crucible Steel Co.	Midland, Pa.	Allis-Chalmers
176	②4000	135/380	750	d-c	Direct	56-in. Tandem cold strip mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
177	②4000	175/470	750	d-c	Direct	56-in. Tandem cold strip mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
178	①4000	40/100	900	d-c	Direct	44-in. Bloom and slab mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
179	①4000	40/100	900	d-c	Direct	44-in. Bloom and slab mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
180	4000	150/336	600	d-c	Geared	66-in. Hot strip mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
181	4000	150/300	600	d-c	Geared	66-in. Hot strip mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
182	4000	110/220	600	d-c	Direct	66-in. Hot strip mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
183	4000	135/270	600	d-c	Direct	66-in. Hot strip mill	Pittsburgh Steel Co.	Allenport, Pa.	General Electric
184	4000	60/150	700	d-c	Direct	32-in. Reversing blooming mill	Sheffield Steel Corp.	Kansas City, Mo.	Westinghouse
185	4000	70/210	700	d-c	Direct	25-in. Structural mill	Colorado Fuel & Iron Corp.	Minnequa, Colo.	Westinghouse
186	②4000	60/150	700	d-c	Direct	Slabbing mill edger	United States Steel Co.	Morrisville, Pa.	Westinghouse
187	②4000	60/150	700	d-c	Direct	Slabbing mill edger	Great Lakes Steel Corp.	Detroit, Mich.	Westinghouse
188	①4000	65/130	700	d-c	Direct	40-in. Blooming mill	United States Steel Co.	Morrisville, Pa.	Westinghouse
189	①4000	65/130	700	d-c	Direct	40-in. Blooming mill	United States Steel Co.	Morrisville, Pa.	Westinghouse
190	5000	60/150	700	d-c	Direct	35-in. Blooming mill	Laclede Steel Co.	Alton, Ill.	Westinghouse
191	①5000	0/40/80	700	d-c	Direct	45-in. x 115-in. Slabbing main drive	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
192	①5000	0/40/80	700	d-c	Direct	45-in. x 115-in. Slabbing main drive	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
193	①5000	40/80	750	d-c	Direct	45-in. Slabbing mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
194	①5000	40/80	750	d-c	Direct	45-in. Slabbing mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
195	5000	110/220	600	d-c	Direct	84-in. Hot strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
196	5000	125/250	600	d-c	Direct	84-in. Hot strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
197	①②6000	70/140	750	d-c	Direct	44-in. Blooming mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
198	①②6000	70/140	750	d-c	Direct	44-in. Blooming mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
199	6000	55/156	700	d-c	Direct	84-in. Reversing mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
200	①②6000	40/80	700	d-c	Direct	Slabbing mill	United States Steel Co.	Morrisville, Pa.	Westinghouse
201	①②6000	40/80	700	d-c	Direct	Slabbing mill	United States Steel Co.	Morrisville, Pa.	Westinghouse
202	①②6000	40/70	700	d-c	Direct	Slabbing mill	Great Lakes Steel Corp.	Detroit, Mich.	Westinghouse
203	①②6000	40/70	700	d-c	Direct	Slabbing mill	Great Lakes Steel Corp.	Detroit, Mich.	Westinghouse
204	②7000	125/250	700	d-c	Direct	Reversing hot strip mill	Lone Star Steel Co.	Lone Star, Tex.	Westinghouse

*Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double Armature

MOTOR RECAPITULATION

Company	*Location*	*Type of mill*	*Number of motors*	*Total horsepower*
Aceros Ecatepec	Mexico	Merchant bar mill	2	1,800
Algoma Steel Corp.	Sault Ste. Marie, Canada	Merchant and skelp mill	13	14,050
Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	56 in. Tandem cold strip mill	5	14,800
Aluminum Co. of America	Alcoa, Tenn.	Aluminum cold strip mill	2	2,000
Aluminum Co. of Canada	Canada	Slabbing mill	1	500
Anaconda Copper Mining Co.	Kenosha, Wis.	Hot strip mill	1	500
Armco Steel Corp.	Ashland, Ky.	80-in. Hot strip mill	1	300
		80-in. Hot strip mill shear	1	900
Atomic Energy Commission	Fernald, Ohio	Blooming mill	1	1,000
Carpenter Steel Co.	Reading, Pa.	Merchant and rod mill	5	2,800
		14-in. Hot strip mill	5	3,600
		20-in. Blooming mill	1	1,250
Colorado Fuel and Iron Corp.	Pueblo, Colo.	Tube mill	7	9,500
		25-in. Structural mill	1	4,000
Connors Steel Co.	Birmingham, Ala.	Breakdown mill	1	1,500
Corporacion de Fomento de la Produccion	Chile	Cold mill	1	750
Crucible Steel Co.	Harrison, N. J.	12-in. Reversing cold strip mill	1	400
	Midland, Pa.	Rod mill	2	4,200
Detroit Steel Corp.	Portsmouth, Ohio	44-in. Bloom and slab mill	2	8,000
Dow Chemical Co.	Midland, Mich.	Cold mill	2	2,850
		Combination hot and cold mill	1	1,500
		84-in. Reversing mill	1	6,000
Fiat Co.	Italy	24-stand Rod and merchant mill	6	3,200
		Skin pass mill	2	1,850
Ford Motor Co.	Dearborn, Mich.	66-in. 3-stand Tandem sheet mill	3	7,500
	Detroit, Mich.	Temper pass mill	4	2,600
Geneva Steel Co.	Provo, Utah	84-in. Sheet temper mill	1	500
Granite City Steel Co.	Granite City, Ill.	36 and 54 x 90-in., 4-high Reversing mill	3	8,000
		45-in. x 115-in. Slabbing mill	2	10,000
Great Lakes Steel Corp.	Detroit, Mich.	Slabbing mill	3	16,000
Hojalata y Lamina S.A.	Mexico	48-in. Skin pass mill	1	400
		48-in. Reversing hot strip mill	1	3,000
		48-in. Reversing cold strip mill	3	2,500
		29-in. Slabbing mill	2	3,800
Hunter-Douglas	Oakland, Calif.	Aluminum sheet mill	1	500
Jessop Steel Co.	Washington, Pa.	2-stand Blooming mill	1	1,250
		4-stand Hot strip mill	1	1,250
Jones & Laughlin Steel Corp.	Aliquippa, Pa.	44-in. Blooming mill	2	12,000
Kaiser Steel Co.	Fontana, Calif.	Temper pass mill	1	600
		84-in. Hot strip mill	2	10,000
Laclede Steel Co.	Alton, Ill.	Billet mill	1	1,000
		35-in. Blooming mill	1	5,000
Laminacao National de Matais	Brazil	4-high Cold mill	1	500
Lone Star Steel Co.	Lone Star, Tex.	Reversing hot strip mill	4	8,550
		45-in. Universal slabbing mill	5	10,200
Madeco Manufacturas DeCobre	Chile	2-high Cold mill	1	400
		3-high Hot mill	1	600
National Standard Co. Athenia Steel Div.	Clifton, N. J.	10-in. and 24-in. x 20 in. 4-high Reversing cold mill	1	800
National Steel Co. of Brazil	Brazil	50-in. Tandem cold strip mill	1	2,000
		50-in. Hot strip mill	1	2,500
National Tube Co.	Morrisville, Pa.	Skelp mill	10	7,600
Ohio Seamless Tube Co.	Shelby, Ohio	Piercing mill	1	1,500
Pittsburgh Steel Co.	Allenport, Pa.	66-in. Hot strip mill	8	23,400
		66-in. Sheet temper mill	3	2,200
		66-in. Single stand 2-high temper pass mill	1	500
		66-in. 4-stand Tandem cold reduction strip mill	8	16,500
Pollack Steel Co.	Marion, Ohio	10-in. Rail rerolling mill	1	800
Republic Steel Corp.	South Chicago, Ill.	Tube mill	8	11,000
Sharon Steel Corp.	Sharon, Pa.	Sendzimir mill	3	1,500
Sheffield Steel Corp.	Kansas City, Mo.	32-in. Reversing blooming mill	1	4,000
Societe Des Acieries De Longwy	France	160-in. Reversing plate mill	1	350
Societe Italiana Accierie Cornigliano	Italy	80-in. Sheet temper mill	1	500
		Hot strip mill	1	900
Timken Roller Bearing Co.	Canton, Ohio	Tube mill	1	2,000
United Iron and Steel	Austria	66-in. Reversing cold strip mill	4	5 350
United States Steel Co.	Morrisville, Pa.	10-in. Bar mill	18	10,200
		4-stand Billet mill	4	5,000
		6-stand Billet mill	6	10,500
		40-in. Blooming mill	2	8,000
		Slabbing mill	3	16,000
Wallingford Steel Co.	Wallingford, Conn.	Sendzimir cold strip mill	3	1,900
Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	45-in. Slabbing mill	3	10,800

Type of motors purchased	*Number of motors*	*Total horsepower*
Alternating current motors	30	34,950
Direct current motors	174	304,250
Total	204	339,200

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, February 25, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Typical Industrial Educational Program for Engineering Graduates," by Geo. D. Lobinger, Westinghouse Electric Supply Co.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, February 12, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

MECHANIZATION OF 12-IN. BAR MILL

1. **"Mill Changes,"** by Geo. A. Henderson, Superintendent of Rolling Mills Division, Bethlehem Steel Co., Lackawanna, N. Y.
2. **"Methods Used in Revamping the Mill Within Short Shutdown Period,"** by James O. Dague, Assistant Superintendent Mechanical Department, Bethlehem Steel Co., Lackawanna, N. Y.

Sheraton Hotel, 715 Delaware Ave., Buffalo, N. Y.

▲

CHICAGO SECTION

Tuesday, February 5, 1952 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Training Maintenance Personnel," by W. Ross Fisher, Assistant Training Advisor, Armco Steel Corp.

Phil Smidt's Restaurant, 1205 N. Calumet Ave., Hammond, Ind.

▲

CLEVELAND SECTION

Monday, February 18, 1952 at Cleveland, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

Tuesday, February 19, 1952 at Youngstown, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Steel Mill Lubrication — Past, Present and Future," by Norwood I. Whiteley, Lubrication Engineer, American Steel and Wire Division, United States Steel Co., Cleveland, Ohio.

Cleveland — Allerton Hotel, Cleveland, Ohio

Youngstown — El Rio Club, Youngstown — Warren Rd., Route 422, Youngstown, Ohio

▲

DETROIT SECTION

Tuesday, February 12, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Preventive Electrical Maintenance," by A. D. King, General Electric Co., Detroit, Mich.

Sales Auditorium, Detroit Edison Co., Service Bldg., 3rd Ave., Detroit, Mich.

▲

PHILADELPHIA SECTION

Saturday, February 2, 1952 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Liquid Waste Treatment," by C. S. Cassels, Plant Engineer, Henry Disston & Sons Co., Philadelphia, Pa.

"Lukens Water Purification System," by N. H. Jensen, Chief Engineer, Lukens Steel Co., Coatesville, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

▲

PITTSBURGH SECTION

Wednesday, February 13, 1952 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"A New Maintenance Tool For Steel Mill Use," by J. J. Barry, Air Reduction Sales Co., New York, N. Y.

"Battery Charging Equipment," by S. K. Lessey, Manager, Service Division, The Electric Storage Battery Co., Philadelphia, Pa.

"Operating Voltages for Battery Operated Trucks," by Charles S. Schroeder, Director of Engineering, Philadelphia Division, Yale & Towne Manufacturing Co., Philadelphia, Pa.

University Club, University Place, Pittsburgh, Pa.

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Continuous Fired
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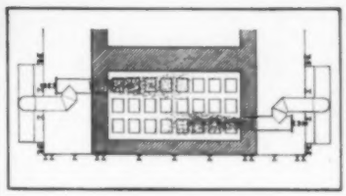
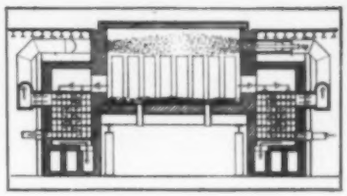


PLAN VIEW



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Fusetron dual-element Fuses—

1* Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

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7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

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One **lost** motor . . .
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One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

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OIL JET INCREASES CUTTING TOOL LIFE

. . . . better application of cutting oils not only increaces tool life, but gives better surface finish, faster speeds and saves time . . . .

▲ A revolutionary twin development which will increase metal cutting tool life from 300 to 1200 per cent and may in time nearly double America's metal cutting capacity was announced recently. The new developments are Hi-Jet and Gulf Hi-Jet Oil, both products of the research laboratories of the Gulf Research & Development Co., a subsidiary of Gulf Oil Corp.

Hi-Jet represents a radical departure from the conventional method of cutting fluid application. Small high-speed jets of oil are directed from below the tool (Figure 1). The streams of oil pass through the space between the work and the side relief face of the tool and are aimed at the line of contact between the work and the cutting edge. Part of the oil is forced past the cutting edge and is caught between the chip and the tool. Hence, the tool is efficiently lubricated, and heat transfer away from the cutting edge is greatly improved.

The entire unit consists of a jet, or a series of jets, flexible tubing, and a small pump capable of providing 400 psi pressure. On many jobs it can be installed in a matter of hours, although some engineering skill is required.

Hi-Jet, which was invented by R. J. S. Pigott, director of engineering research of the Gulf Research & Development Co., will be manufactured by Thompson Products, Inc., of Cleveland, Ohio, under licenses from Gulf Research & Development Co. Current tooling schedules indicate delivery of the first production units about July 1, 1952.

Hi-Jet can be applied to most turning operations and is practical for most operations using single point tools. Details of its application to other types of machining operations are now being developed. The new system was in the experimental stage for nearly a year, and over 600 tests have been made on a variety of metals ranging from SAE 1020 to titanium. All the tests showed a remarkable

Figure 1 — A small high-speed jet of oil directed from below the tool passes through the space between the work and the side relief face of the tool. The tool is efficiently lubricated and heat is efficiently transferred away from the cutting edge.

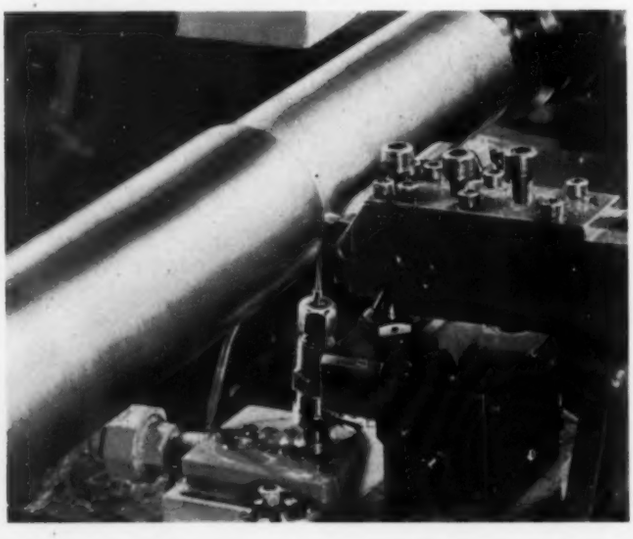
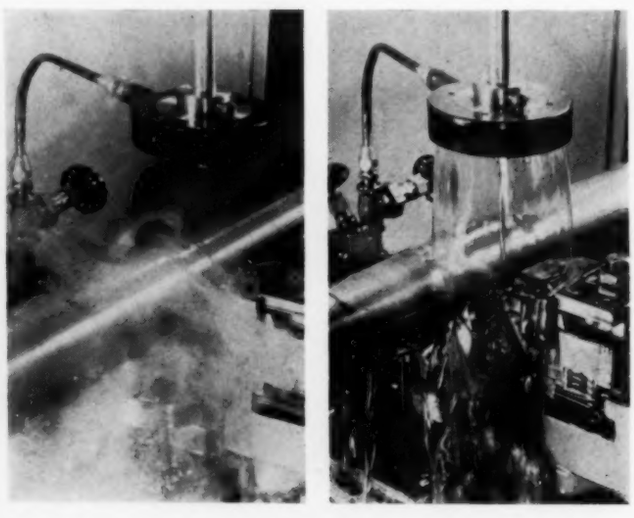


Figure 2 — Evidence that oil actually reaches the cutting edge of the tool is shown in the photo at the left. Photo at the right shows a curtain of oil which consists of shower heads above and beneath the Hi-Jet, which almost completely eliminates the smoke.



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29 yrs.	AGE	29 yrs.
165 lbs.	WEIGHT	165 lbs.
39"	CHEST	39"
7"	WRIST	7"
32"	WAIST	32"

He loses the tough matches

. . . there's more to a "Champion" than the tape measure shows!

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- **HOLDS TRUE DIMENSIONS**
- **LESS DOWN TIME**
- **LONGER PRODUCTION RUNS**
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improvement in cutting tool life, with the increase on high speed tools from 6 to 12 times and on carbide tools from 3 to 5 times.

For use in the new system, a special oil, known as Gulf Hi-Jet Oil, has been developed. This came as a result of tests on more than 50 types of oil, which entailed the development of 35 new oils plus the testing of more than 15 existing oils.

Since the Hi-Jet oil gets to the exact point of contact between the cutting tool and work surface, there is considerably more heat carried away, and as a result a great deal more smoke is generated. For this reason a number of attachments have been developed which will serve as smoke quenchers (Figure 2).

One of these attachments is a series of shower heads placed above and below the cutting surface. It will utilize the available overhead flood equipment, but by using the liquid to form a thin curtain rather than a single river, it provides a much more effective job. The addition of this equipment, however, in no way influences the operation of Hi-Jet, since it is merely a smoke quencher and is in no way a lubricant or a coolant.

One of the outstanding advantages of this new system is the fact that the operator has the choice of operating his machine at conventional speeds with a greatly increased tool life or doubling, and sometimes even tripling, his speed of operation with no resultant reduction in tool life.

Results of tests indicate that the use of a jet small enough to enter the gap between the heel of tool and the work has greatly improved penetration at any jet speed. There is no disturbance by cross flow from splash on the tool. The cooling is greatly improved, since contact with the tool is direct, the flow velocities are far higher, and the liquid is applied in a thin sheet. The greater cooling is easily proved by the reduction of edge temperature. Two to three times the cooling is obtained with one-twentieth the oil circulation.

A considerable increase in vapor and smoke (when not using an auxiliary quenching stream) shows that the cutting liquid is boiling near the cutting edge. The liquid passes the edge of the tool, probably as vapor, and recondenses on top of the tool as a result of the cooler work and chip. It passes up through the channels occasioned by the difference in roughness between the cut face and the tool.

Hi-Jet and Gulf Hi-Jet Oil also offer other indirect advantages. As a result of increased tool life, setup and tool grinding time on many jobs can be greatly reduced. And because the tools last longer, fewer tools are needed. On large production jobs this means substantial savings in tool inventory and tool cost.

It seems certain that with the great improvements now made possible in high-speed tool life and cutting speeds, the use of high-speed tool steels will be greatly increased. This is especially desirable at the present time because of the scarcity of sintered tungsten carbides and the increasing demands brought about by the nation's defense program.

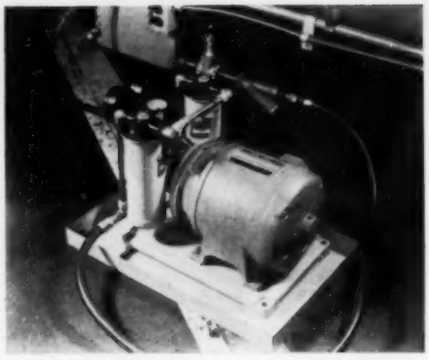

Figure 3 — Oil is supplied to the jet nozzle by this unit which includes a motor-driven pump, filters and flexible tubing.

TABLE I

Test Results of Overhead Flood with Conventional Coolants vs Hi-Jet with Gulf Hi-Jet Oil

Steel	Cutting conditions	Tool		Tool life			
				Overhead flood		Hi-Jet	
		Material	Shape	Oil	Time, min	Oil	Time, min
SAE 3150	110 sfm 0.011 in. feed 0.150 in. depth of cut	18-4-1 high-speed steel	10-12-8-10-6-6-3/64	A B	10.02 12.60	Gulf Hi-Jet oil	177
AISI 3140	140 sfm 0.011 in. feed 0.150 in. depth of cut	18-4-1 high-speed steel	10-12-8-10-6-6-3/64	B C D A	9.3 24.0 16.0 23.0	Gulf Hi-Jet oil	339.5
SAE 1020	212 sfm 0.033 in. feed 0.125 in. depth of cut	18-4-1 high-speed steel	0-8-8-8-8-5-1/32	E	1.27	Gulf Hi-Jet oil	19.5
AISI 416 Stainless	160 sfm 0.011 in. feed 0.150 in. depth of cut	18-4-1 high-speed steel	10-12-8-10-6-6-3/64	F	9.4	Gulf Hi-Jet oil	163.4

Because of the improved cooling and lubricating action on the tool radius, surface finish is greatly improved with this new method. Test results have shown a reduction in surface roughness from 200 to 60 microinches (rms). Even where improvements in surface finish are not so pronounced, greater dimensional stability usually results; the effects of tool build-up and radius wear are practically eliminated.

An important advantage of the improved surface finish and dimensional accuracy is the reduced need for additional finishing operations. In some cases the finishing operation can be entirely eliminated. Grinding time, too, can often be reduced because of the smaller dimensional variations.

Another advantage is a reduced tendency toward work hardening of the machined parts. On some jobs this may mean that stresses which cause distortion and surface hardening are reduced.

Case History No. 106

Rolling Mill Screwdown

9/10 LESS Lubricant Used

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Water Repellence . . . Effectiveness is not reduced by water.

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Iron Plating Restores Worn Parts

By RUSSELL PYLES
Vice President and Chief Engineer
Van Der Horst Corp. of America
Olean, N. Y.

▲ A few years ago the Van der Horst Laboratories made a thorough study of all known methods of electrodepositing iron. After three years of intensive work, a distinctly new plating bath (for which patent applications are in process) has been developed, which will plate a resulting iron called Vanderloy M that has very satisfactory physical properties.

Microscopically, this new electrolytic iron develops a fine, columnar structure, with the close packed, columnar grain perpendicular to the surface with which it is bonded. Thus, it offers much the same grain-on-end resistance to the forces of wear as the grain-on-end wood block of heavy-duty, factory floors.

The bond, established atomically between Vanderloy M and the base metal of parts plated with it, is indestructible. The application of enough force to tear one of the metals apart fails to disrupt its atomic adhesion to the other. While the Vanderloy M now in production is practically pure electrolytic iron, we have laboratory indications that we can adapt the bath to alloy plating. The alloy program, however, is a long-term development project.

PLATING BATH

The entirely new Vanderloy M type of bath is especially well suited for the plating of heavy deposits. As these deposits build up to substantial thickness, there is neither excessive grain growth nor roughness. The latter difficulties often are encountered in the plating baths heretofore known. Vanderloy M deposits can be made of ¼-in. radial thickness, or more. The limit of thickness, therefore, may be considered as determined by economics and design, rather than by the plating bath.

Distinguishing features of the bath itself are that it remains stable, and produces the above results within practical limits of current density and working temperature.

This moderately acidic bath is operated at a surprisingly moderature temperature as compared with such baths as the hot ferrous chloride solution. The advantage of low temperature permits "masking," or "stopping-off" with the easy and low-cost use of wax. The important problem of bagging likewise has been solved. Bags made either of Vinyon or Orlon contain the low-carbon steel scrap used as anodes. Since all substances remain completely dissolved, the bath is a true solution and, therefore, lends itself either to continuous or periodic filtration.

Preparation is essentially that required in general plating, consisting of the usual degreasing anodic alkaline cleaning, necessary stopping-off of areas not to be plated, and, just prior to plating, anodic etching in a sulphuric acid bath.

This etch not only cleans the metal but is adjusted to remove a superficial amount of metal which generally exists as a "cold smear," or a fragmented, crystal-distorted surface, resulting from previous machining.

Thereby, the Vanderloy M is deposited upon, and bonds atomically with a virgin metal surface which is free from fragmentation and residual stress.

In both the alkaline and sulphuric baths the piece to be plated is made anode and not cathode, thus minimizing the absorption of hydrogen. This is especially important on parts which are subjected to stress in operation. While pre-cleaning methods eliminate occlusion of hydrogen in the part to be plated, some hydrogen is occluded during the plating operation because the part must necessarily be made cathode.

No effort is made to remove this hydrogen when Vanderloy is deposited in engine cylinders, as tensiles and elongation of the thin layer in the cylinder is relatively unimportant. Furthermore, in operation, the cylinder is subjected to a long-term, low-temperature heat treatment which drives off the hydrogen. However, on parts subjected to stress, such as crankshafts, a heat treatment of several hours at 600 F effectively drives off hydrogen.

PHYSICALS

Variations in bath composition and plating conditions can produce Vanderloy M with a tensile strength as high as 100,000 psi or as low as 50,000 psi. For the present, we have established the conditions for production which approximate physicals averaging as follows:

Tensile strength	75,000 psi
Yield point	60,000 psi
Brinell hardness	200-210

Vanderloy M as now plated on outside diameters and surfaces, machines about the same as alloy steels, having a tendency to be tough. Machining can be accomplished, however, with high-speed steel cutters.

Machining of inside bores is more difficult but honing and grinding, of course, are readily done.

Fatigue tests are now in progress to determine the endurance limit of Vanderloy M and its effect on the endurance limit of the base metal. Normal expectation would be that it would behave as all ferrous metals and have a limit for complete reversal of approximately 40-50 per cent of its ultimate strength.

PLATING PROCEDURE

From receiving inspection, the parts are first dipped in an alkaline solution to cleanse them and remove rust. The cleaning and reconditioning of badly worn or scrapped parts may occasionally entail welding shut of small breaks, cracks, or chipped holes in the surface to be plated.

After being cleansed and rinsed, the worn bearing surfaces of each part is machined. To illustrate, cylinders are rebored to eliminate ring steps, sluted wear and scoring, and to re-establish concentricity of the bore. Thereafter, the oil, with which the cylinder wall has become impregnated during use, is baked out. This prevents a seepage that might upset later plating steps.

On ported cylinders it is necessary to radius the port edges with an abrasive wheel, and to protect such areas with paint. Port radiusing prevents excessive "treeing," or piling up, of the actual plate on sharp edges during application of Vanderloy M. Painting of the ports prevents the plating from becoming distributed beyond the cylinder wall proper. The protection of all other areas on which plating is not desired is accomplished by dipping the parts in molten wax. Thereafter, they are assembled in plating fixtures and are ready for renewal with Vanderloy M. By immersion in a tank of sulphuric acid, the parts are submitted to a brief electro-etch to prepare the plating surface for atomic bonding with Vanderloy M. After rinsing, the multiple fixtures and parts are hoisted into a tank containing the electrolyte.

When iron plate of desired thickness has been built up on the bearing surfaces, the parts load is detached from the plating current and transferred to the rinse tank. Thereafter, the wax masking is removed by hot water treatment, followed by immersion in a tank of protective oil. Then the parts are disassembled from the fixtures.

Grinding of the edges of the plated areas, to re-establish clearance and necessary radii (as in cylinder liners at their ports and both ends), completes the operation.

TYPICAL APPLICATIONS

As the critical parts of industrial equipment wear out in use, they are being restored by Vanderloy M. For about a third less than the price of new replacements, such items as power and compressor cylinders, crankshafts, and the like, are being renewed and sent into regular service.

When less than a thousandth of the weight of expensive bearing parts wears away, the function of mechanical assemblies in which they are used is disrupted. Since bearing surfaces wear unevenly, the usual expedient has been to machine away more of the surface in order to restore smoothness and provide new dimensions that can be used with odd-sized mating parts. Repeated, such deliberate removal of bearing surfaces obviously hastens the wearing out of parts to the point at which they have to be scrapped and replaced with new ones.

As a typical example, renewal of a 20-in. diesel cylinder liner is accomplished with 12.3 lb of Vanderloy M. This saves 1720 pounds of high-quality casting and extensive machining, for which the price of replacement is approximately $1550.00.

Besides the saving already enumerated, an additional one of major value is the elimination of any need to produce, purchase or carry in stock any odd-sized parts. All such present stock can be returned to standard size and, as they wear, can be reprocessed again and again.

END-WELDED COLLAR STUDS INCREASE *Reheat Furnace Availability*

....stud welding provides the key to many new techniques....

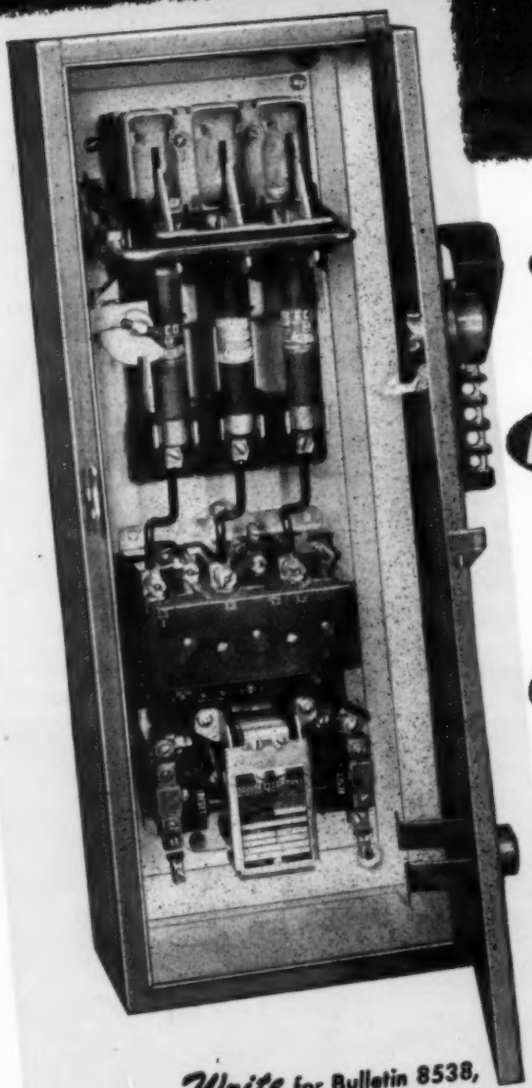
By ROBERT C. SINGLETON
Manager of Industrial Sales
Nelson Stud Welding Division
Gregory Industries, Inc.
Lorain, Ohio.

▲ A new design and maintenance procedure for slab and billet reheating furnaces in steel rolling mills shows great promise for increasing production and at the same time reducing costs.

Because of the high temperatures in reheat furnaces, it has been found necessary to water cool the skid tubes, crossovers and uprights in order to maintain the strength required for support. There are inherent disadvantages involved in water cooling the slab supporting structure that have been recognized for a long time. With bare tubes, a large quantity of heat is lost from the furnace through the pressurized cooling water. This heat is unavailable for heating the slab and increases the heating time required. Exposed, comparatively cool tubes result in local cold spots on the billets and necessitate a soaking period so the slab can attain a uniform temperature. Thus, more time and production is lost in removing cold or black marks.

Bare tubes are exposed directly to the oxidizing effect of the flame and to the corrosive products of combustion. This leads to scaling of the tubes on outside and inside and results in

DESIGN LEADERSHIP



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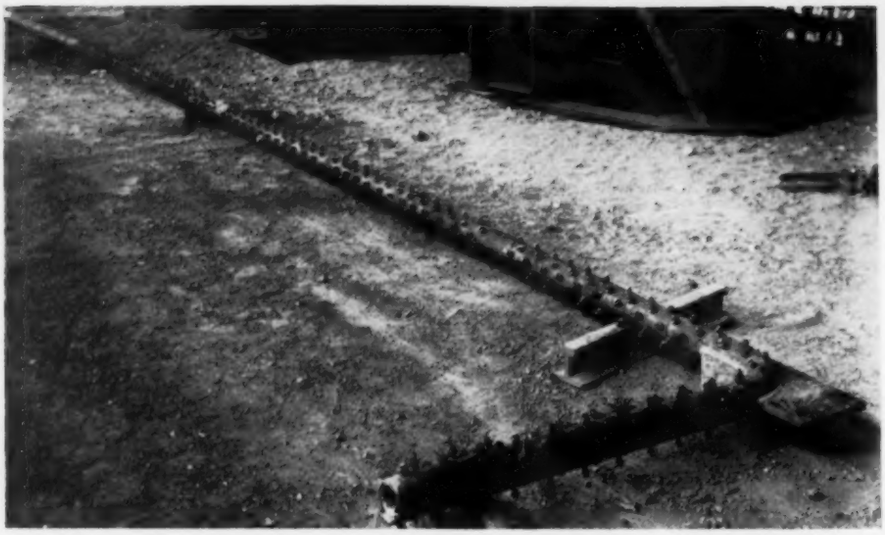


Figure 1 — Completed skid tube ready for installation in slab reheat furnace. Note open spaces where studs are omitted to provide space for the crossover pipes.

hot spots and early tube failure. Loss of cooling water pressure is another factor that can lead to tube failure and furnace down time.

With this background, it was obvious that rolling mill operators would attempt to insulate the slab supporting structure. Uniform cross section studs were hand welded to the non-bearing surfaces of the skid tubes, and the crossover and upright pipes. A refractory material was rammed in between the studs to act as insulation. The total effect of this method was a gain in performance but at considerable expense.

The refractory material did not hold too well to the plain studs, and the hand welded studs did not provide the optimum heat transfer path between the studs and the pipes. The refractory would fall out in chunks and caused local hot spots on the tubes that led to early failure.

The next step in insulating the slab support structure was the introduction of end-welded, gun-applied threaded studs, on which nuts were turned part way down. This step accomplished two things. It provided a positive lock to hold the refractory in position, and, because end welding produces a complete weld, it provided the optimum heat transfer path comprising the complete stud area. However, although the results were better and it was less expensive to gun-weld the studs, a great deal of time was expended in screwing nuts on to the studs by hand.

The most recent development in the insulation of skid tubes is a gun-welded stud that has an integral collar about half way up its length. This gives the same result as was obtained by screwing a nut on a threaded stud, but avoids all the extra time required for the nut. The operator applies the studs, and the skid tubes are immediately ready to be packed with the chrome ore refractory.

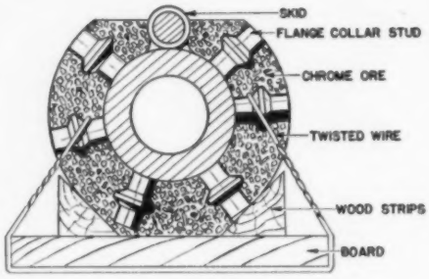


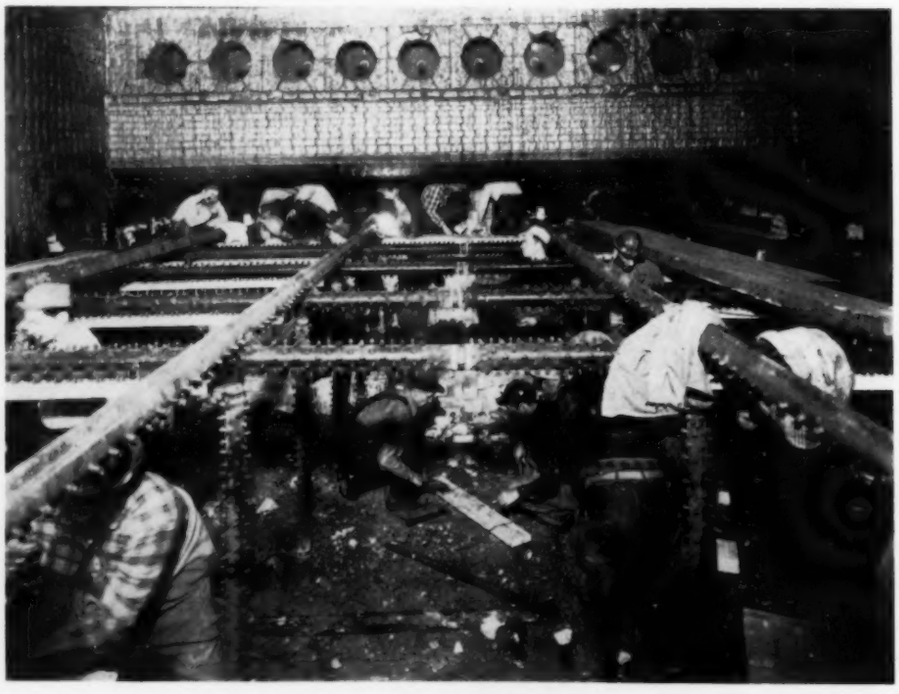
Figure 2 — Schematic diagram shows the physical relationship between the various components used when insulating skid tubes and support pipes.

Insulation of skid tubes, and crossover and upright pipes has decreased heat loss from the furnace to the support structure cooling water by from 20 to 25 per cent. This saving shows up as reduced fuel consumption and/or faster slab heating cycles. Insulated tubes avoid black marks on the slabs caused by the cool skids, and make unnecessary the soaking period that is required when the slab has cold spots.

Since the cooling water temperature is lower and the tube surface is cooler, the rate of internal scaling of the tubes is greatly reduced. The outside surfaces of the slab supporting members are protected by the refractory so that external scaling and corrosion are greatly lessened. This means far less maintenance and greater furnace availability.

The net effect of insulating skid tubes is to increase the tonnage per reheat furnace while reducing overall expenses per ton of steel processed. Initial installation of insulation is more expensive than leaving the

Figure 3 — End view of furnace with skid tubes. Crossover and vertical supports are in place. Boards are being installed prior to placement of the chrome ore refractory.



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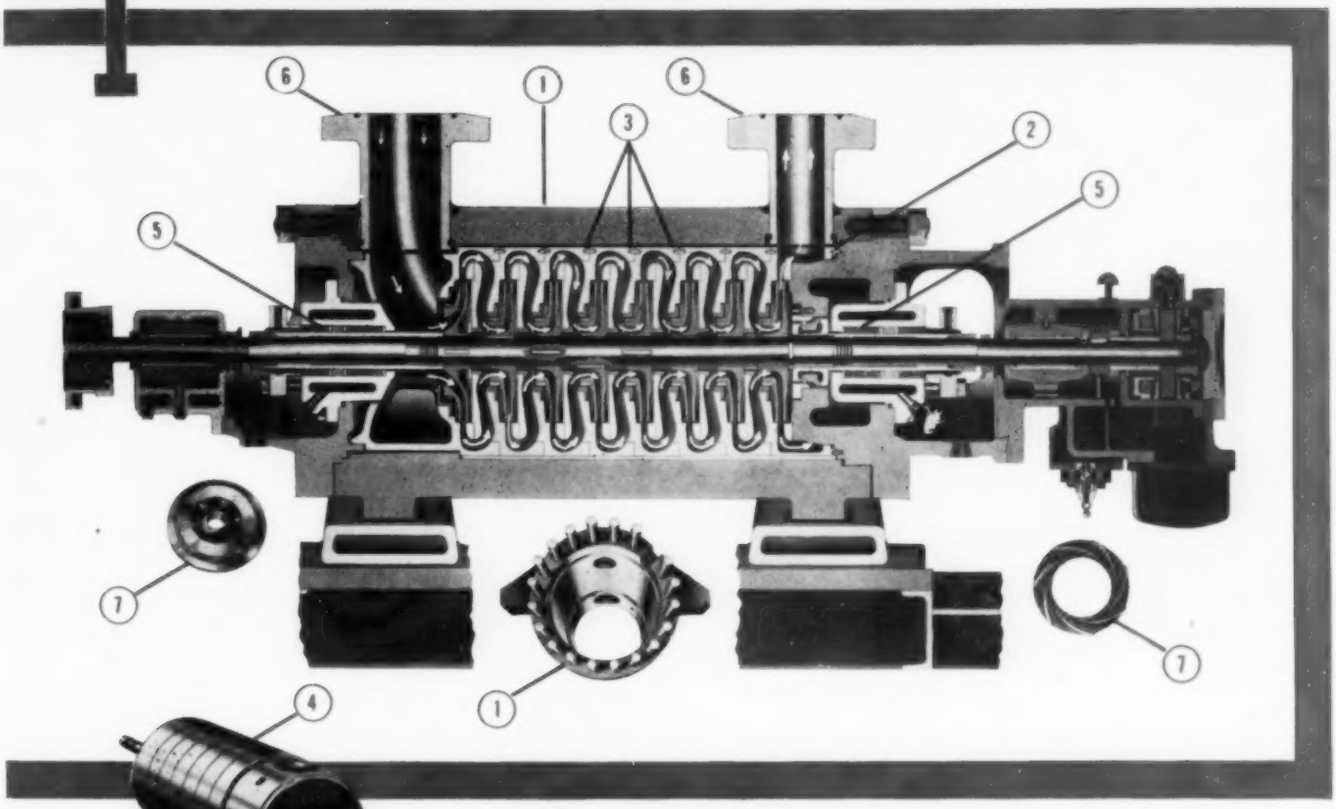

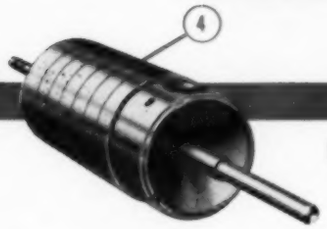

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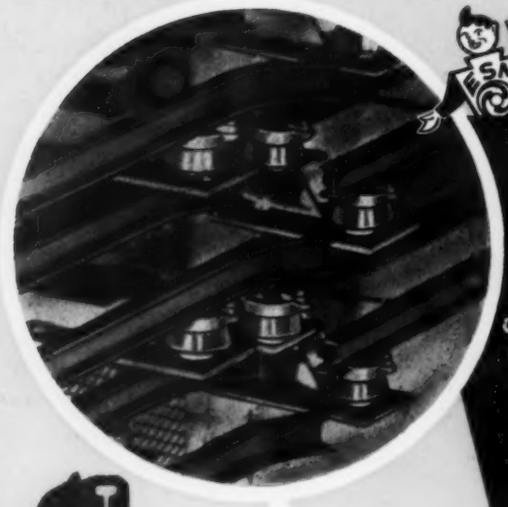

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tubes bare, but the investment is more than repaid over the life of the supporting structure. With labor and fuel costs constantly increasing, large savings can be realized by insulating skid tubes.

One mill operator has found that by insulating the skid tubes and supports, and adjusting the heating cycle to the new conditions, the stack temperature has dropped 400 F. This drop results from the reduction in heat input, another indication of the vast improvement in the overall efficiency of the furnace.

Skid tubes, and crossover and upright pipes are fabricated completely as shown in Figure 1. All tubes should be clean and free from scale. If they are not clean, they should be wire brushed. Standard end-welding methods are used to secure the ½-in. collar studs to the tubes on approximately 2¾-in. centers, staggered. Usually, longitudinal lines are scribed on the tubes to facilitate location. Studs can be applied at a rate between 3 to 5 per minute per gun. No studs are placed at those points where the skid tubes contact the crossovers. Chrome ore is omitted at those same points to allow for pipe expansion.

Boards about 1 in. thick and about 2 in. wider than the finished diameter of the insulated pipe are wired in position on the under sides of all horizontal pipes. Wires should be no farther than 2 ft apart and should be twisted tight so no movement of the boards will occur during application of the chrome ore. The diagram of Figure 2 shows how the boards act as shelves to hold the chrome ore while it is being applied and setting.

Two men working on opposite sides of the pipe section press the chrome ore firmly between lower studs with small, stiff trowels. To insure thorough packing, the ore is rammed between the studs with a flat-nosed stick, the size of which gives minimum clearance between tube, support board and studs. Continuing with the trowels, and moving the trowel toward the material already applied to attain good adhesion, the lower half of the tube is finished until flush with the outer ends of the studs. The remainder of the tube is finished in the same manner.

If the chrome ore shows a tendency to sag from the lower part of the pipe before air-set occurs, 45-degree wood strips are applied, as in Figure 2, between the chrome ore and the supporting board.

The chrome ore is vented with a carpenter's awl or an 8d nail. Holes should be about 1 in. apart and penetrate the full depth of the insulation. If time permits, the refractory should air-set for two hours before venting so the holes will remain uniform.

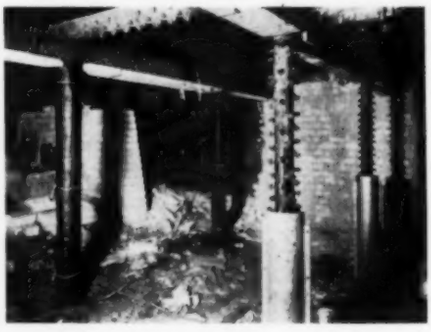
Vertical studded pipes are insulated by applying the chrome ore, using the same small, stiff trowels, at the base of the pipe and working upward. The ore should be packed thoroughly and without voids. As with horizontal studded tubes, the chrome ore should come flush to the end of the studs, but not beyond.

To prevent possible sagging of the chrome ore prior to airset, each pipe should be wrapped spirally with 4 or 5-in. strips of cloth or tough felt roofing paper as the insulation is completed. Wires are wrapped outside the cloth strips to secure them tightly. Vent holes are made through the wrapping and the chrome ore. If additional support is needed, wood strips can be wired in position over the wrapping material.

When the complete support structure has been insulated, the temperature of the furnace is brought up in the usual manner. Direct flame impingement on the insulated pipes should be avoided during the early stages of warm-up. The boards, wires and wrappings burn off and are not removed prior to furnace warm-up.

Many mills prefabricate a complete support structure to keep down time to a minimum when the structure is replaced. This same stock of spares can be used where just one portion of the structure must be replaced. The welded tubes, with the collar studs in position, are carried in stock, and it is only necessary to cut away the old structure, assemble the new supports and apply the chrome ore. As an additional aid to minimum replacement time, some operators maintain a stock of removable forms for use in applying the chrome ore to vertical pipes, as shown in Figure 4.

Figure 4 — Partially completed installation shows boards in position under horizontal tubes and some completed vertical pipes. Vertical pipes at left have been insulated and wrapped with burlap. Pipes at right have removable forms to aid in placing the chrome ore.



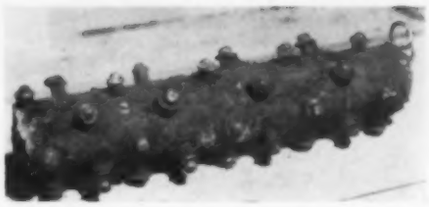


Figure 5 — Section of skid tube after completion of furnace run shows excellent condition of studs and tube, indicating the effectiveness of insulating material in reducing scaling.

Some slab reheating furnace operators have anticipated that repairs to insulated skid tubes would be difficult, but the opposite has been found. Inasmuch as the tubes are insulated against flame impingement and the corrosive action of combustion products, tube repairs are not required as often as on bare tube installations. However, should a pipe leak, steam will be formed at the bad spot and will break away the chrome ore. This acts as a telltale to instantly locate the trouble area.

Where the tube rupture is small, the tube is cleaned with a hammer and wire brush, and the break is welded. Where the break is a major one, the ruptured section of tubing is cut out. A new section of tube is welded in place, and the collared studs are affixed. In both instances, the repaired area is repacked with chrome ore and the furnace is again ready for production.

The end-welded, collar studs supporting chrome ore do a good job of tube insulation as seen in Figure 5. This is a section of tube that has completed a furnace run. The chrome ore has been removed to show the comparatively scale-free surface of the tube.

Outstanding as these results are, they represent just one phase of the story of how gun-welding of studs increases production and reduces costs in the steel industry. Other examples of increased production with lowered costs are found in the use of end-welded studs and rammed chrome ore for open hearth doors, studded runner boxes, dog houses and pouring spouts.

FOR ALL HYDRAULIC SYSTEMS

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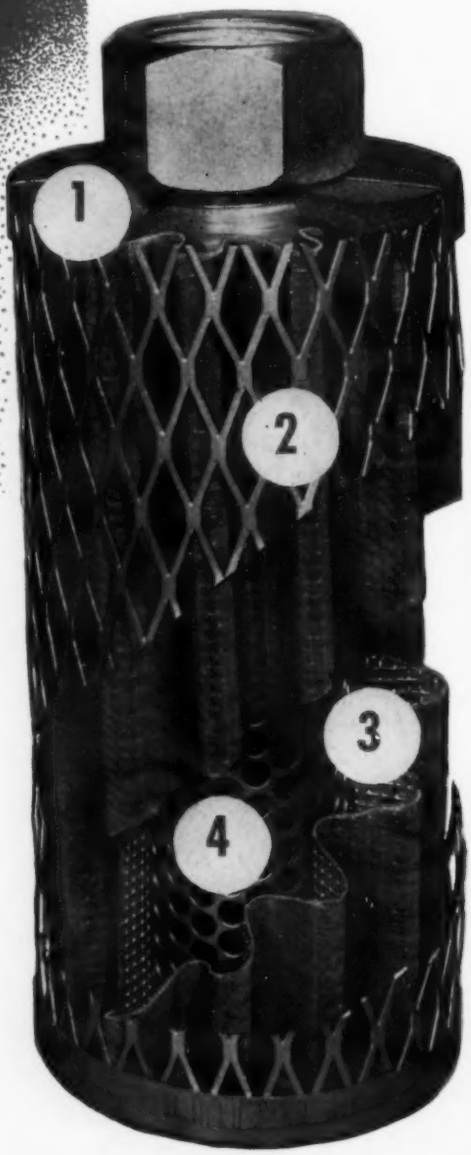

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3. Reinforced Insert. Extra strong wire for a reinforcement to maintain the design of insert for a long serviceable period.

4. Centering Tube. The core of the filter gives a sturdy construction to the whole unit; adds protection for the pump should maintenance of the filter be neglected.

Marvel Synclinal Filters are simple, efficient and have great capacity for space occupied. This permits longer operation between cleanings. Any workman can disassemble, clean and reassemble a Marvel on the spot resulting in the equivalent of a new unit. No moving parts to get out of order. No need to stock spare parts.

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Leading machine manufacturers have adopted Marvel to preserve the efficiency they build into their machines. Many companies are improving and simplifying their maintenance by standardizing with Marvel filters on all their machines. Available in 5 to 100 g.p.m. sizes with greater capacities obtainable through multiple installations. Mesh sizes from 30 to 200. Marvel has the right answer for filtering non-corrosive liquids in all hydraulic and low pressure systems.

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At the exposition which covers your industry or trade, more potential buyers can and do inspect the products of more exhibitors than they could possibly do in any other way in anything like the same time.

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IRON AND STEEL EXPOSITION

September 30 through October 3, 1952

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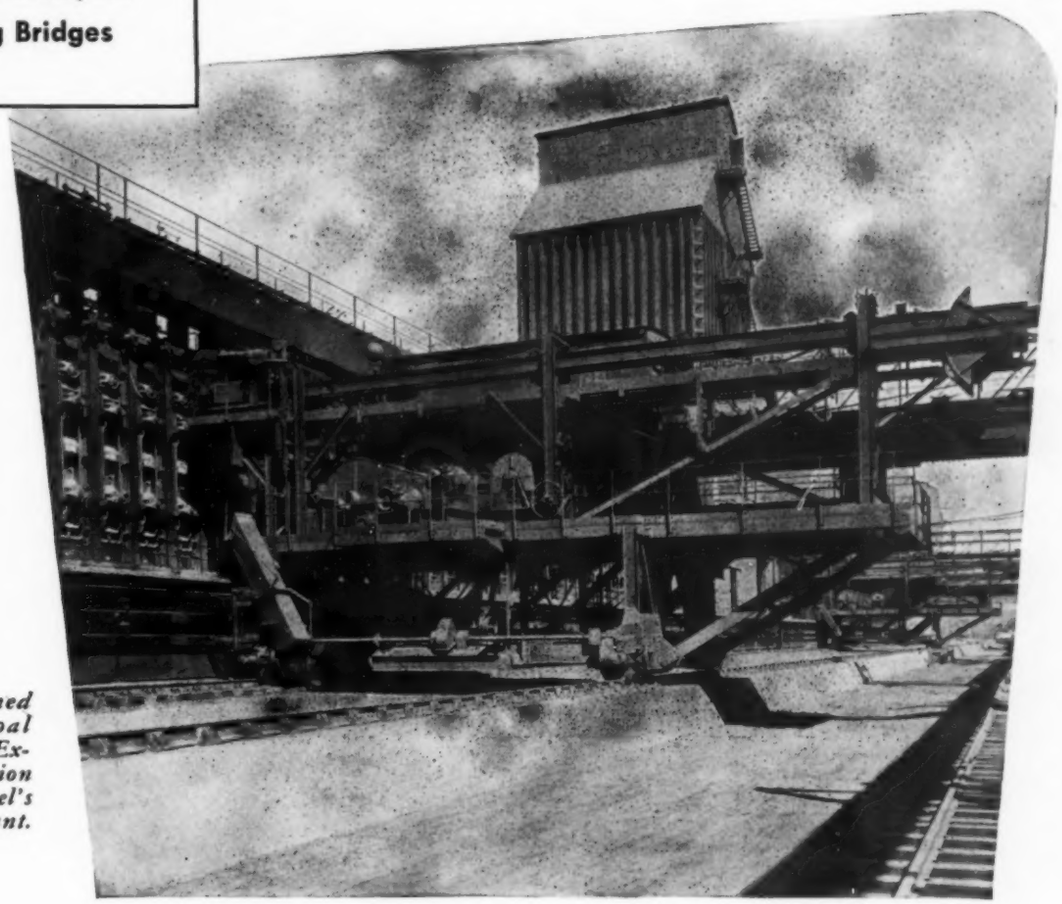
Wellman Coke Pushers

for the Modern Coke Plant



Wellman Combined Coke Pusher, Coal Leveler and Door Extractor in operation at Bethlehem Steel's Lackawanna Plant.

● Many of the world's most modern byproduct coke oven plants are Wellman equipped. The Wellman Engineering Company's more than half-century experience in building heavy machinery guarantees sound design and expert construction. Wellman equipment provides peak economy, maximum safety and trouble-free performance under a wide variety of operating conditions. For conservative, reliable recommendations on your heavy equipment, phone or write:

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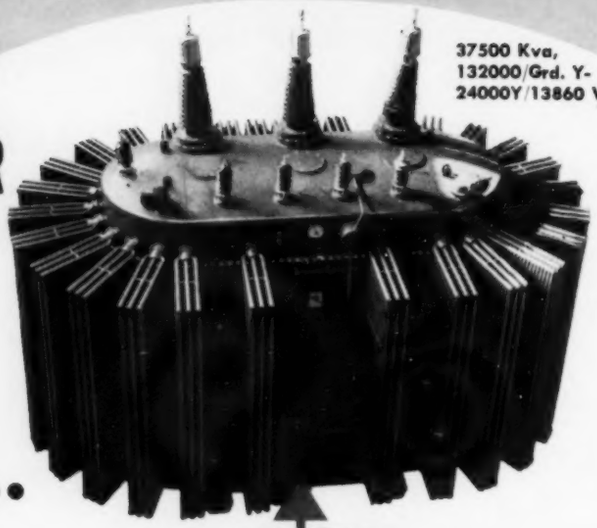
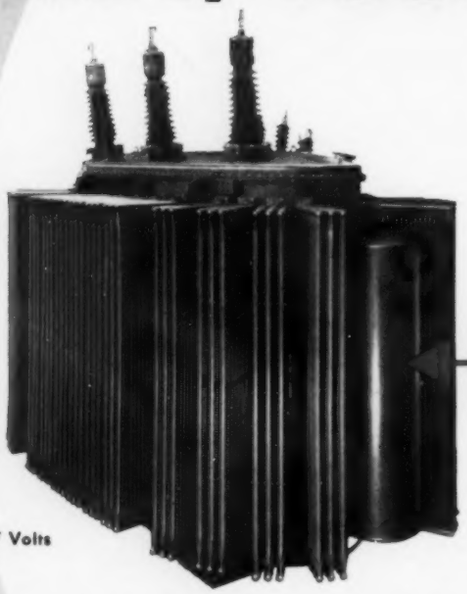
One of these large SELF-COOLED POWER TRANSFORMERS could have been ordered by YOU...



37500 Kva,
132000/Grd. Y-
24000Y/13860 Volts



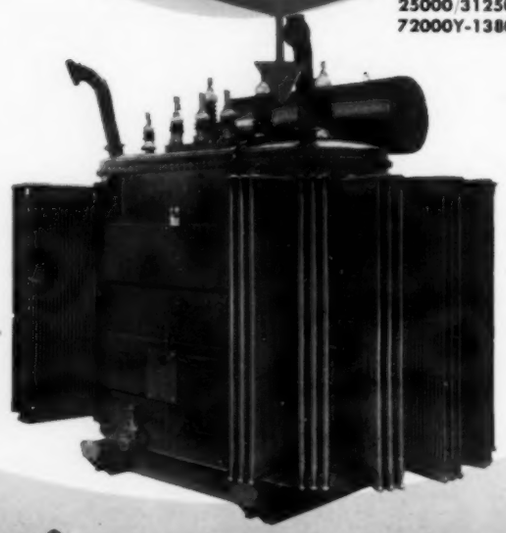
20000 Kva,
110000Δ-
34500 Grd. Y Volts

INERT GAS PRESSURE

INERT GAS-OIL SEAL

Method of OIL PRESERVATION

OIL EXPANSION TANK



25000/31250 Kva,
72000Y-13800Δ Volts

If you are a user of transformers, you probably prefer a particular method of oil preservation for your transformers.

Here are three Power Transformers that were recently manufactured by Pennsylvania Transformer Company. Of special interest is the fact that each transformer is equipped with a different method of oil preservation.

No doubt one of these methods, if not all of them, would meet with your requirements. But no matter what oil preservation method you specify, you can be certain that when it is incorporated into a Pennsylvania Transformer, it will function efficiently with the same amount of dependability as the rest of the transformer.

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PA. • *Greater Pittsburgh District*

trantinyl

guides the steel industry

ROLLING MILLS:
bar, hoop, strip, shape
mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling
mill plugs and rolls,
piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing
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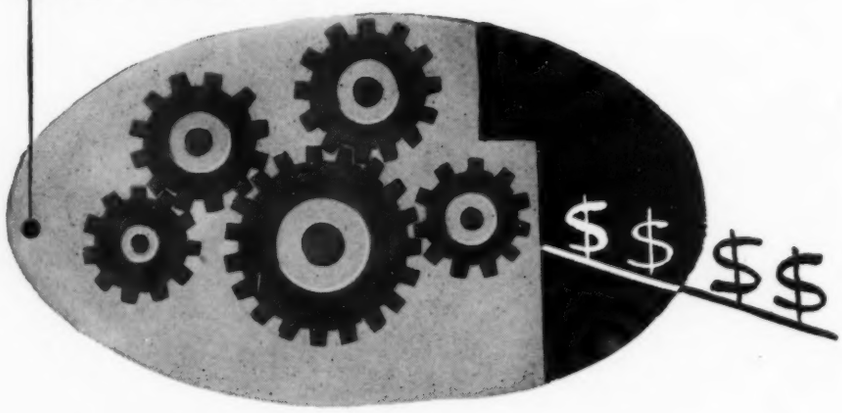
STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

YOUNGSTOWN ALLOY CASTING CORP. • YOUNGSTOWN, OHIO

WANTED CORPORATION PRESIDENTS

to start the machine that manufactures SECURITY



This machine operates best when started by top management! It's the ***Payroll Savings Plan*** for the regular purchase of U. S. Security Bonds. It produces security for individuals, for business, and for the nation at large.

Security for individuals . . . because every $3 invested in Security Bonds pay $4 at maturity.

Security for business . . . because the billions of dollars already invested—and being invested—in Bonds are building future purchasing power.

Security for the nation . . . because every Bond dollar that is built up in the Treasury is used to retire a dollar of the national debt that is potentially inflationary, and because every Bond held means fewer dollars to go to market to bid up prices on scarce goods.

Produces Other Benefits, Too!

In 19,000 industrial concerns operating the Payroll Savings Plan, employees are more contented. Worker production has increased, absenteeism has decreased—even accidents have been fewer!

Why Should Top Management "Press the Button"?

Begun in war-time, the Payroll Savings Plan was rapidly and widely adopted under the stimulus of dramatic patriotic appeals.

Those appeals are gone. Yet the reasons for investing in Security Bonds today are important. Management men can understand these reasons—and have the influential authority that's needed to "start the machine"... to get the Plan vigorously promoted.

Your Task Is Easy—and Vital!

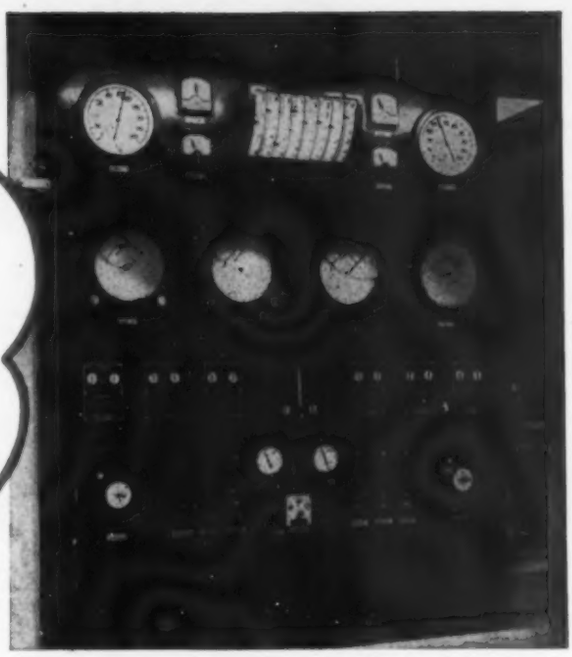
To enable you to install or to reinvigorate the Plan in your company, with minimum time and effort, the Treasury Department has prepared a kit of materials especially for you to distribute among specific key personnel. Be sure to get and use your kit! Your sponsorship of the Plan will bring you its greatest benefits in your own company—and you'll be doing your part to help guarantee America's security—***which is your best business security.*** For help, call your Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

IRON AND STEEL ENGINEER

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council.

TIPS ON HOW TO SELECT BOILER CONTROL



Bailey Boiler Control Panel for a 300,000 lb. per hour pulverized coal fired boiler. Both combustion and three-element feed water controls are based on accurate measurements made by meters located on this control panel.

1 Profit From the Experience of Others

It is likely that plants of the type you are considering are being already operated at optimum performance by Bailey Boiler Control. When you select Bailey Controls, you profit from this experience and get the benefit of the latest refinements in application. Over 8,000 boiler units have been equipped with Bailey Controls during the past 10 years. These units range from 3,000 to 1,000,000 lb. per hour capacity and operate at pressures from 75 to 2500 psi. They are fired by pulverized coal, stokers, oil, gas, mixed fuels and waste fuels.

2 Call In Qualified Engineers

Bailey Engineers are qualified by training and experience to consult with you on both the theoretical and practical aspects of your boiler control problems. These specialists in combustion, measurement, and automatic controls are conveniently located in over 30 industrial areas throughout the United States and Canada. Your local Bailey Engineer stands ready and willing to apply the Company's know-how to your plant.

3 Specify a Dependable System

Records indicate that compressed air is a reliable operating medium. Unlike electricity or oil, it continues effective for a time after power failure.

Bailey Boiler Controls are sturdy air-operated units which function in accordance with accurate measurements made by Bailey Meters.

4 Avoid Make-Shift Applications

The wide selection of both measuring and controlling elements offered by Bailey Meter Company provides complete flexibility of control application. The correct combination of these elements does a thorough job without excessive equipment.

5 Insure Smooth Operation

Coordination of related control systems such as combustion, feed water, steam temperature, and condensate flow insures against costly disturbances in plant operation. Proper coordination improves control action, increases safety of operation, reduces auxiliary power required and reduces storage capacity needed in heaters and boiler drums.

6 Be Sure You Can Get Service

Users of Bailey Control have but to call on the nearest branch office of Bailey Meter Company to secure the services of a trained engineer.

For Your Plant

If you want details write for a copy of Bulletin 15-D, or ask a Bailey Engineer to call.

BAILEY METER COMPANY

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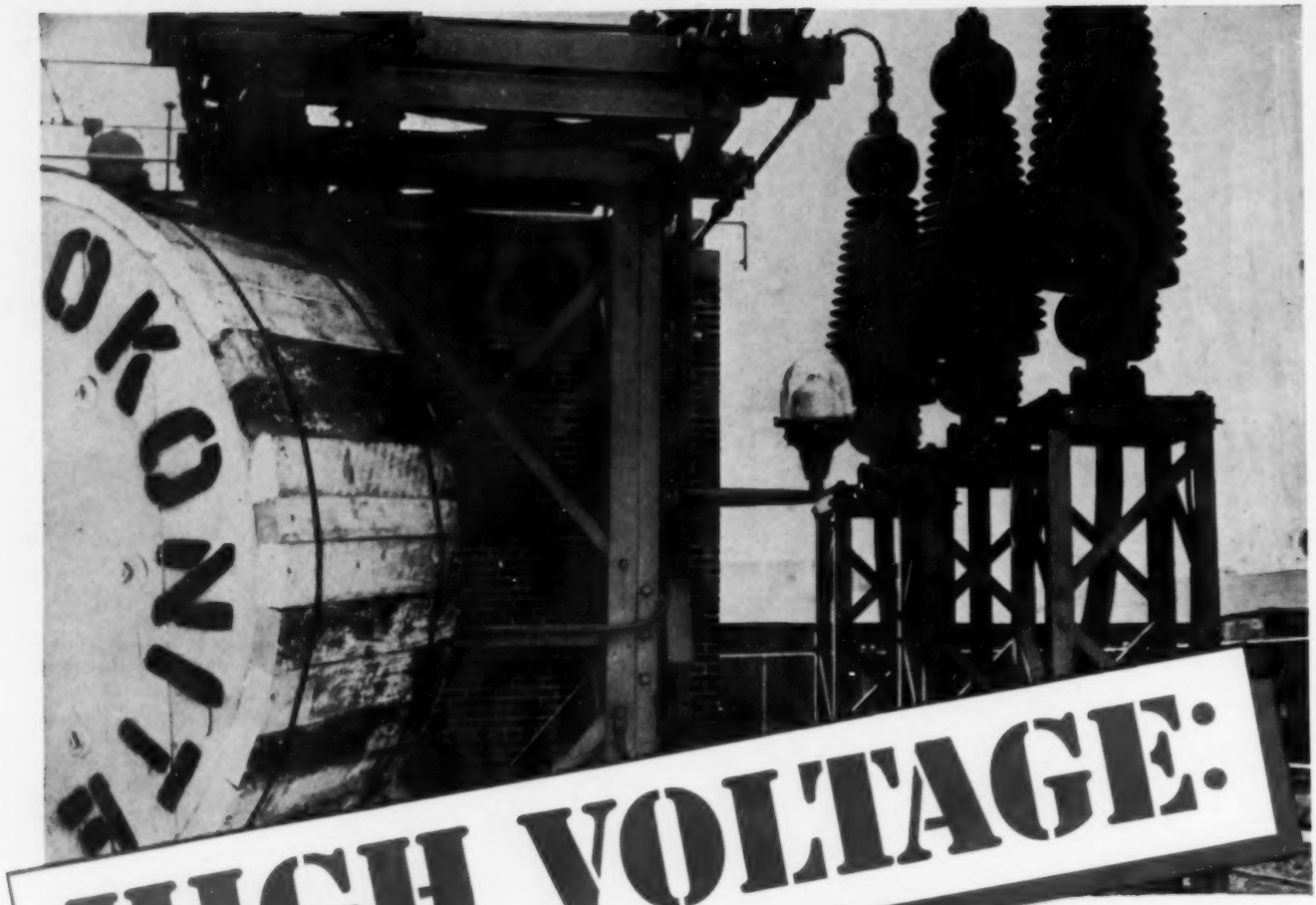
Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

A97-1



HIGH VOLTAGE:

HANDLE IT WITH OKONITE

For handling high voltage power, electrical engineers want equipment that has a high safety factor and an established record for reliability. These characteristics, long associated with Okonite products, are chief among the reasons why engineers continue to specify Okonite insulated cables for high voltage circuits and for other difficult and exacting jobs.

When engineers specify "Okonite" they know they are getting the benefits of over seventy years' experience in designing, making and installing cables. They also know that Okonite's three plants provide the most versatile facilities in the industry. For example:

When Okonite engineers are asked to recommend a cable design they are not confined by manufacturing limitations, since only Okonite is equipped to insulate cables by *all* the known methods, and uses all of them in regular production.

What about abnormal sizes or lengths? Okonite has made cables nearly six inches in diameter . . . only recently completed a single 7½ mile length of outsize cable that required 9 gondola cars for shipment.

Voltage limitations need be no concern. Okonite has always been a leader in the high voltage field, recently accepted the first order ever placed in America for 161,000 volt underground cable.

Okonite's versatility serves the buyer in other ways, too . . . in use of new and better materials, in advanced testing and research, in the kind of planning and thinking that results in greater value for your cable dollar. When you are adding new electrical circuits, it will pay you to specify "to be made by The Okonite Company, Passaic, New Jersey."

The best cable is your best policy

OKONITE OKONITE SINCE 1878 *insulated wires and cables*

9680

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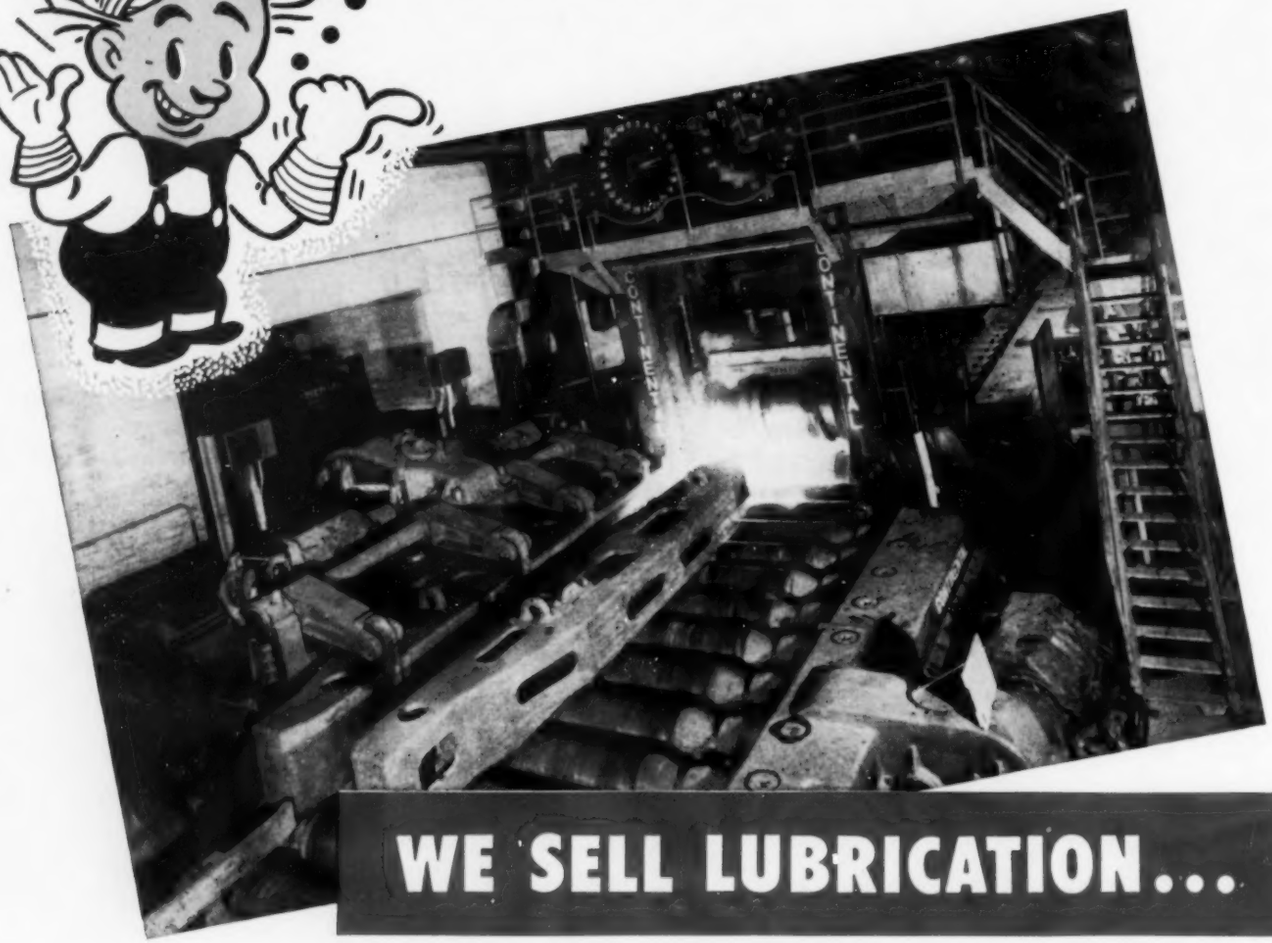
"THERE ARE MORE *Trabon* AUTOMATIC LUBRICATING SYSTEMS IN OPERATION THAN ALL OTHER MAKES!"



WE SELL LUBRICATION...

Which means Trabon customers get a lubricating system which—day after day, month after month, and year after year—properly lubricates your bearings, with a minimum of down time and maintenance.

No shutdowns for bearing failure . . . no work stoppage for lubrication . . . Trabon lubricates as your machines produce . . . delivers the right amount of lubricant to each bearing.

Trabon oil and grease systems operate in heat and cold; in high or low places . . . in dirt, dust, ice, water, grime; withstand vibration and pounding.

Repeat orders from old customers prove the merit of Trabon. Trabon Lubricating Systems are your insurance against costly down time, bearing failures and lost production.

Trabon

OIL AND GREASE SYSTEMS

TRABON ENGINEERING CORPORATION

1814 East 40th Street • Cleveland 3, Ohio

Date-line Diary...

December 1

▲ Pennsylvania Railroad ordered 180 new diesel electric locomotives and 5000 freight cars at a cost of $60,000,000. It also appropriated $12,000,000 for new rail and a freight car repair program.

December 3

▲ Based on reports of companies having 93 per cent of capacity of the industry, the operating rate for the week beginning December 3 is set at 103.6 per cent of capacity. This is equivalent to 2,071,000 tons of ingots and castings compared with 2,079,000 tons one week ago.

December 4

▲ David Austin, United States Steel, and J. V. Honeycutt, Bethlehem Steel, testified that the steel industry is headed for overproduction.

▲ Stockholders of Allegheny Ludlum Steel Corp. voted to increase authorized indebtedness from $20,000,000 to $40,000,000.

December 5

▲ DPA chief Fleischmann stated that steel scrap collections and allocations may be taken over by the government if private efforts fail.

▲ International Materials Conference proposed that tungsten distribution and prices be regulated under a four year international agreement. Of the 65,000 tons estimated annual production of tungsten, 35,000 would go to the United States.

December 6

▲ OPS authorized price increase applications by producers under the Capehart Amendment.

▲ AAR reports estimated new income of railroads during October totaled $85,000,000 compared with $108,000,000 for the same month in 1950.

December 7

▲ ICC announced that it will hold further hearings on the railroad's request for full 15 per cent increase. From 6 to 9 per cent of this was granted last August.

▲ American Railway Car Institute announced that freight car production in November totaled 9824. Orders were 6752 leaving a backlog on December 1 of 129,158.

December 8

▲ AISI reported more steel was shipped in the first ten months of 1951 than in any full year prior to 1950 with a total tonnage of 65,981,000 tons.

December 9

▲ Secretary of Commerce Sawyer stated that business outlook for 1952 is good. He stated also that steel, copper and aluminum will be scarce, but rubber will probably be decontrolled.

December 10

▲ Steel production for the week beginning December 10 is scheduled at 104.1 per cent of capacity. This is equivalent to 2,081,000 tons of ingots and castings compared with 2,071,000 tons one week ago.

December 11

▲ Kaiser poured first aluminum from the new $150,000,000 Chalmette Production plant near New Orleans.

December 12

▲ Aluminum Association reported that primary aluminum production in October totaled 145,293,592 lb, or about 6,400,000 lb over September.

▲ AISI reports payroll for the iron and steel industry in October was about $250,000,000, the highest for any month. Wage earners received an average of $1.931 an hr, for an average work week of 41.4 hr. Total employment was 674,000.

▲ NPA gave machine tool builders a new and better priority called Z-2.

▲ Canadian steel output for the first nine months of 1951 totaled 2,320,975 tons or up about 300,000 tons for the same period in 1950.

December 13

▲ Pittsburgh Steamship Co.'s 61 vessel fleet moved a record 26,000,000 gross tons of ore down the lake in 1951.

December 14

▲ Government intervened in the steel wage dispute sending two mediators to Pittsburgh.

▲ French National Assembly voted to ratify the Schuman Plan which pools the coal and steel industries of six West European nations.

December 15

▲ Canada ended all foreign exchange controls.

▲ Economic Stabilizer Putnam stated that the government will not permit the steel industry to raise prices to offset any wage increases that might be granted the CIO steelworkers.

▲ Ward's Automotive Reports estimated that auto production in 1951 would be about 5,335,000 units or the second largest in history.

December 16

▲ Pittsburgh Consolidation Coal Co. awarded Blaw Knox a contract to build a large pilot plant at Library, Pa.

December 17

▲ CIO steelworkers wage policy committee authorized a strike at a meeting today.

▲ Foreign lead prices dropped about 3¢ a lb to 19¢ a lb.

▲ Operating rate for the steel industry is scheduled at 104.9 per cent of capacity for the week beginning December 17. This is equivalent to 2,097,000 tons compared with 2,081,000 tons one week ago. This will be the largest amount of steel ever made in one week.

December 18

▲ Agriculture Department forecast that the 1951 corn crop will fall to 2,941,000,000 bu.

▲ DPA set production expansion goals which call for an output of 120,000,000 net tons of steel, 85,000,000 net tons of iron, and 84,000,000 net tons of coke annually by the beginning of 1954. In addition, expansion of taconite beneficiation was set at 16,500,000 net tons of iron ore at the beginning of 1956.

December 19

▲ DPA stated that beginning the first quarter of 1952, direct defense and defense related production will take more than 40 per cent of the carbon steel, and 60 per cent of aluminum, copper wire mill products and copper brass mill products.

▲ F. W. Dodge Corp. estimates construction awards east of the Rockies for the first eleven months of 1951 at $14,516,792,000 or greater than any previous whole year. During November awards totaled $931,768,000.

December 20

▲ AISC estimates that shipments of structural steel in 1951 totaled 2,700,000 tons or more than in any year in the past twenty.

▲ John L. Lewis promised to help the CIO steelworkers if they go on strike.

▲ NPA will limit and standardize auto storage battery output to conserve lead.

▲ Commerce Department estimates that capital expenditures for the first quarter of 1952 will reach $5,729,000,000. Total 1951 capital expenditures were placed at $23,100,000,000.

December 22

▲ Cyrus Ching handed the steel wage dispute over to Harry Truman.

December 24

▲ Based on reports from companies having 93 per cent of capacity of the industry, the operating rate for the week beginning December 24 is scheduled at 101.4 per cent of capacity. This is equivalent to 2,027,000 tons compared with 2,097,000 tons one week ago.

December 25

▲ Merry Christmas.

December 26

▲ ARCI estimated that railroad car production in 1951 totaled about 96,000 new freight cars. This is somewhat under the goal of 10,000 cars per month set at the beginning of the year.

▲ Walter S. Tower estimated steel production in 1951 at 105,000,000 tons. Estimated annual steel capacity at the beginning of 1952 is about 107,000,000 tons.

December 27

▲ Edison Electric Institute estimates that electric utilities will spend $2,750,000,000 for construction in 1952 or $500,000,000 more than 1951.

December 28

▲ AISC reports November bookings of structural steel total 193,668 tons and shipments of 218,236 tons. Total backlog totals 2,437,668 tons.

▲ E. W. Bliss was awarded a $500,000 contract to design and manufacture equipment for the hot strip mill in the Volta Redonda, Brazil plant.

▲ CIO steelworkers called off strike scheduled for New Year's day.

December 29

▲ Steel industry and union leaders were called to a meeting in Washington set for January 7.

December 30

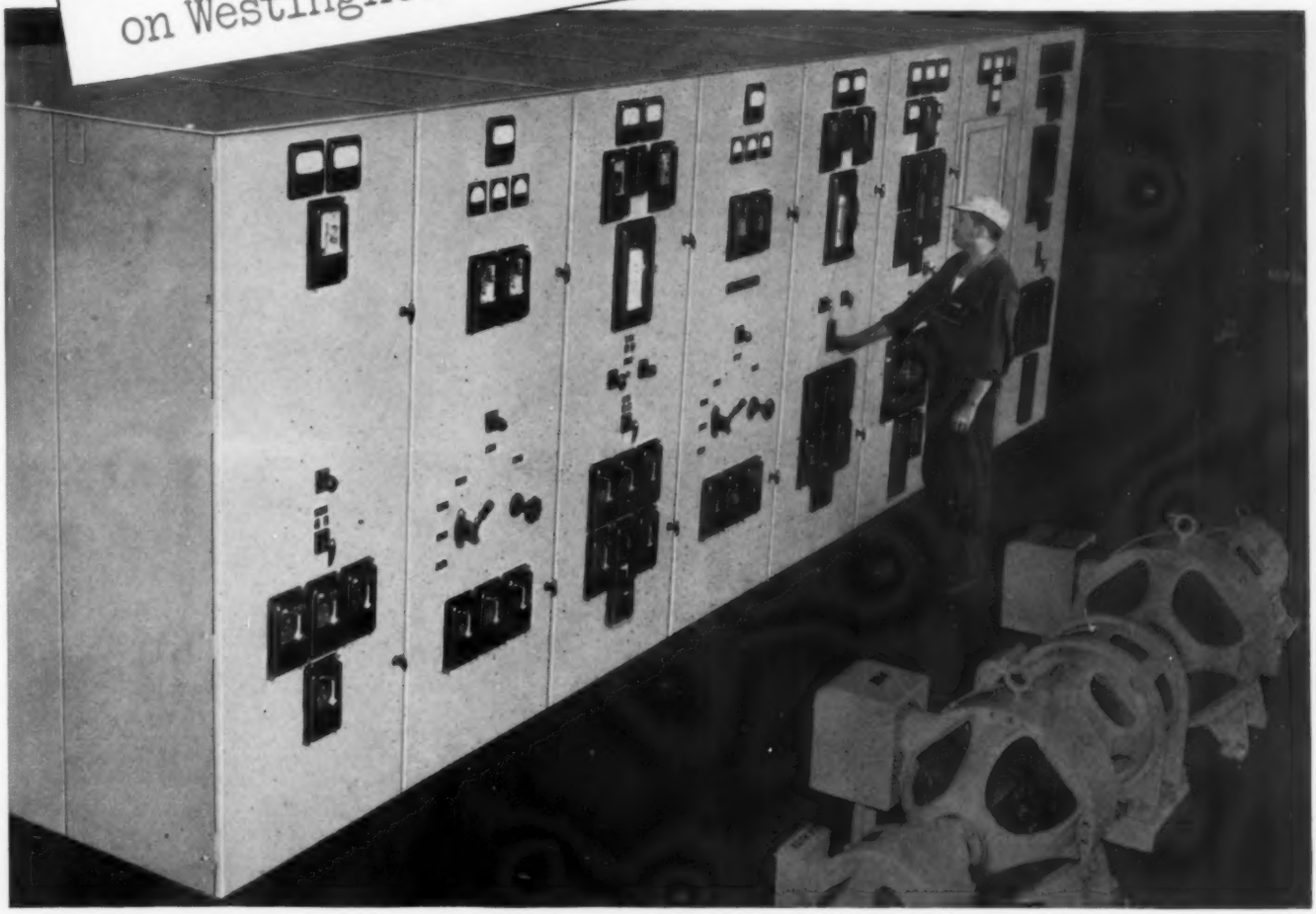
▲ Federal Power Commission approved a $11,400,000 annual rate increase for the Tennessee Gas Transmission Co.

▲ National Steel, Youngstown Sheet & Tube, and Steel Co. of Canada took over a two-thirds interest, and the Pittsburgh Consolidation Coal Co. took over a one-third interest in the Mathies Coal Co. Mathies Mine produces about 1,750,000 tons of metallurgical coal annually.

December 31

▲ The operating rate of the steel industry beginning December 31 was scheduled at 102.0 per cent of capacity. This is equivalent to 2,039,000 tons of steel ingots and castings compared with 2,027,000 tons one week ago.

Weirton Steel Company reports on Westinghouse Switchgear



"It's Safe...Dependable...Economical!"

This attractive installation of Westinghouse Metal-Clad Switchgear serves the No. 5 Tandem Mill at Weirton Steel Company, Weirton, W. Va. It also serves this user's interests in other respects as this statement indicates:

"Your complete factory-assembly of this unit enables us to reduce substantially normal ordering and installation costs. Less engineering time was required and the installation was made quickly and simply.

"From a safety standpoint, we particularly like its interlocking and isolation feature which eliminates hazards in operation. The unit has been entirely reliable in service."

Unusually low maintenance is another feature that's sure to increase this customer's satisfaction with Westinghouse Switchgear. Several important reasons—easy accessibility . . . drawout air breakers . . . exclusive "De-ion®" circuit interruption.

For complete information on Westinghouse Metal-Clad Switchgear, ask for Booklet B-4016. Contact your Westinghouse Representative or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60773

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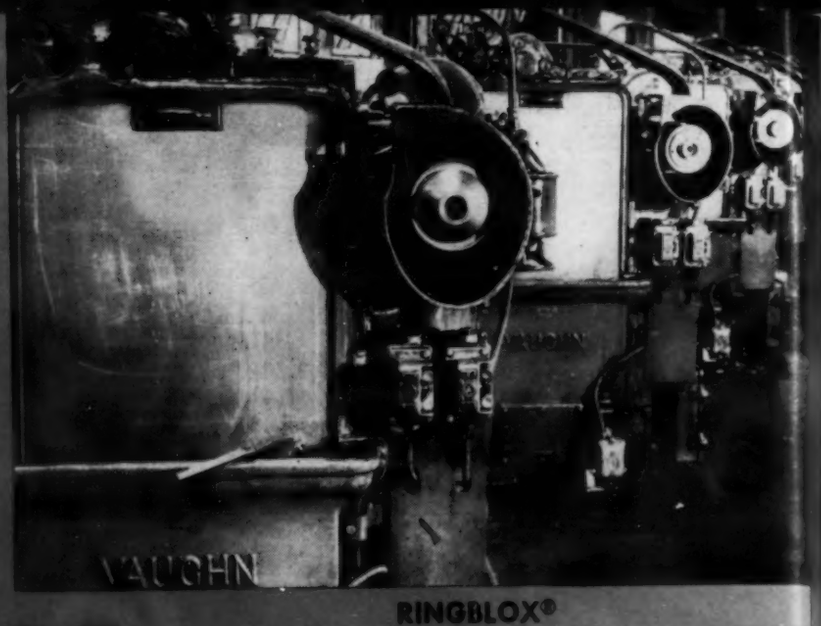
HIGH FLEXIBILITY
mean
HIGH PRODUCTION
on every assignment



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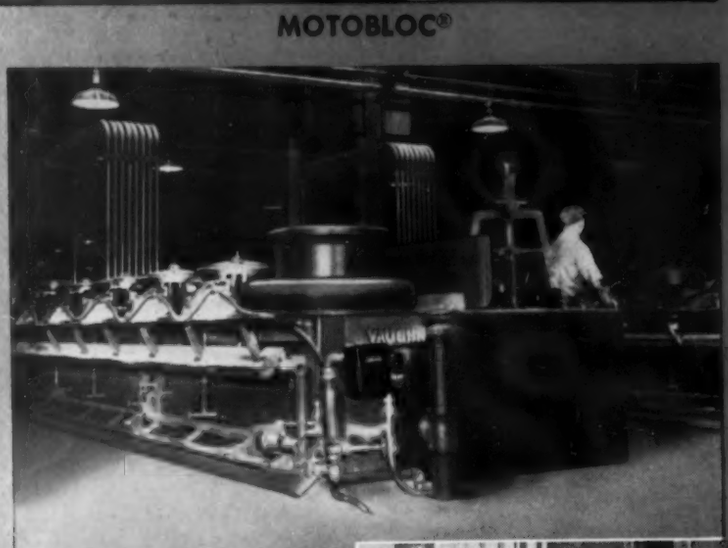
COLD DRAWING EQUIPMENT

From finest wire to heavy bars, tubes and shapes, Vaughn Cold Drawing Equipment provides fast, smooth production with maximum versatility in operation. The reasons are matters of fact—easily demonstrable, clearly superior! May we point out Vaughn's profit-potential for you?

THE VAUGHN MACHINERY CO.
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.



MOTOBLOX®

DRAW BENCHES

Industry News...

CRANE DELIVERIES MAY BE RESCHEDULED BY NPA

▲ Problems involving the possible rescheduling of deliveries of cranes to new steel mill facilities to assure the handling of new production during 1952 were discussed recently at a conference of hot metal crane manufacturers, steel producers and the National Production Authority, U. S. Department of Commerce.

Many new steel-producing facilities such as open hearth and electric furnaces, blooming mills and others will be ready to turn out steel for the mobilization program between now and 1953, and all these must be equipped with cranes for moving the steel from place to place in the mills.

The two principal manufacturers of these heavy cranes told the steel company representatives and NPA that they received unusually large orders over a short period of time. As a result it has been difficult for them to keep up with the engineering of specially designed cranes. Efforts of these companies to keep pace with scheduled deliveries of cranes also has been hampered by difficulties in obtaining materials and component parts, they reported.

NPA officials said that every possible assistance will be given to the manufacturers of the heavy cranes to help them meet scheduled deliveries during the nine-month period from September 1, 1951 to July 1, 1952. Schedules previously established for deliveries of steel mill cranes during that period have been "frozen." The manufacturers said they would require early NPA assistance to carry out scheduled deliveries.

The 42 steel mill representatives were asked to prepare lists of the charging cranes, soaking pit cranes, ladle cranes, stripper cranes and other special cranes that they will need to operate their new production facilities.

Scheduled for production by the crane manufacturers in the program to increase the nation's output of steel are about 277 traveling cranes. These will be installed in the new mill facilities as rapidly as they can be built and delivered. The different types of cranes required for these purposes have a lifting potential ranging from less than 10 tons to more than 425 tons.

TUBE SUBSIDIARY BECOMES DIVISION OF B&W

▲ Babcock & Wilcox Tube Co., a wholly owned subsidiary of Babcock & Wilcox Co., was dissolved, effective December 31, 1951. The tube company's business and assets will be absorbed by, and it will be operated as, one of the divisions of Babcock & Wilcox Co. thereafter.

The announcement, made jointly by the boards of directors of both companies, emphasized that the transfer of the plants and business of the tube company will have no effect upon its continued operation so far as the customers and employees of the subsidiary are concerned and will not change Babcock & Wilcox Co. stockholders' equities. The tube facilities will be operated as the Tubular Products Division of the company and Luke E. Sawyer and Edward A. Livingstone, tube company officers, will also become officers of Babcock & Wilcox Co. The announcement said the change would be beneficial from an organizational and managerial standpoint.

Babcock & Wilcox Tube Co. has its main offices at Beaver Falls, Pa., with plants at Beaver Falls and Alliance, Ohio.

NPA ACTS TO RELIEVE STEEL MILL BOTTLENECK

▲ To eliminate some confusion within the nation's steel industry, and particularly to remove some of the major bottlenecks retarding the program to expand the production of iron and steel, the National Production Authority, U. S. Department of Commerce, has formally announced that, effective with the second quarter of 1952, a number of items of blast furnace and steel works equipment have been declared Class "A" products.

NPA said that the following prod-

COIL TRANSFER CAR FOR FAIRLESS WORKS

Clyde Berkebile at U. S. Steel's Johnstown, Pa., works, directs assembly of the first coil transfer car to be shipped soon to Fairless works, new sister plant now under construction near Morrisville, Pa. The large 130-ton car will be used to transfer large steel coils in the new plant's sheet mill. Berkebile and Edward Kirk are assembling the big car body to the wheel trucks.

BETTER LONGER!

RUN-OUT TABLE
ACTUAL SERVICE RECORDS
OF THREE YEARS
WITHOUT
MAINTENANCE

★ On run-out tables, as well as on other equipment, Lovejoy Flexible Couplings are giving outstanding performance. They feature free-floating load cushions suspended between heavy metal jaws. Cushions will last two to five years *and there is no shut-down for changing*. These couplings instantly counteract mis-alignment, vibration, backlash and surge. To eliminate costly break-downs and shut-downs due to coupling failure on run-out tables and other equipment, use Lovejoy Flexible Couplings. No lubrication ever required.

WRITE FOR COMPLETE CATALOG AND HANDY, QUICK-FINDING SELECTOR CHARTS

LOVEJOY FLEXIBLE COUPLING CO.
5093 WEST LAKE STREET CHICAGO 44, ILLINOIS
Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

ucts are now "A" products: blast furnace tuyeres; blast furnace bosh plates; blast furnace stack coolers; blast furnace stove, valve seats; blast furnace ladle cars; blast furnace slag thimbles; open hearth furnace steel ladles; open hearth furnace slag thimbles; charging boxes; electric furnace charging buckets; slab and billet heating furnaces; charging and ingot cars.

NPA officials explained that steel producers will be able to obtain allotments of steel for this equipment, and pass on the required allotments to the firms who are to build these items.

The "A" procedure affects only new equipment, NPA explained. The regulations governing the procurement of maintenance, repair and operating supplies are not affected by this action.

Blast furnaces, open hearth furnaces and blooming mill soaking pits are regarded as construction projects, and material will be allocated in the same manner as "A" products.

Insulated copper wire is defined as a controlled material, and when used in construction it is necessary for a steel company to obtain an allotment of this for its own use or to pass it on to the contractor, if the company uses a contractor to do the work.

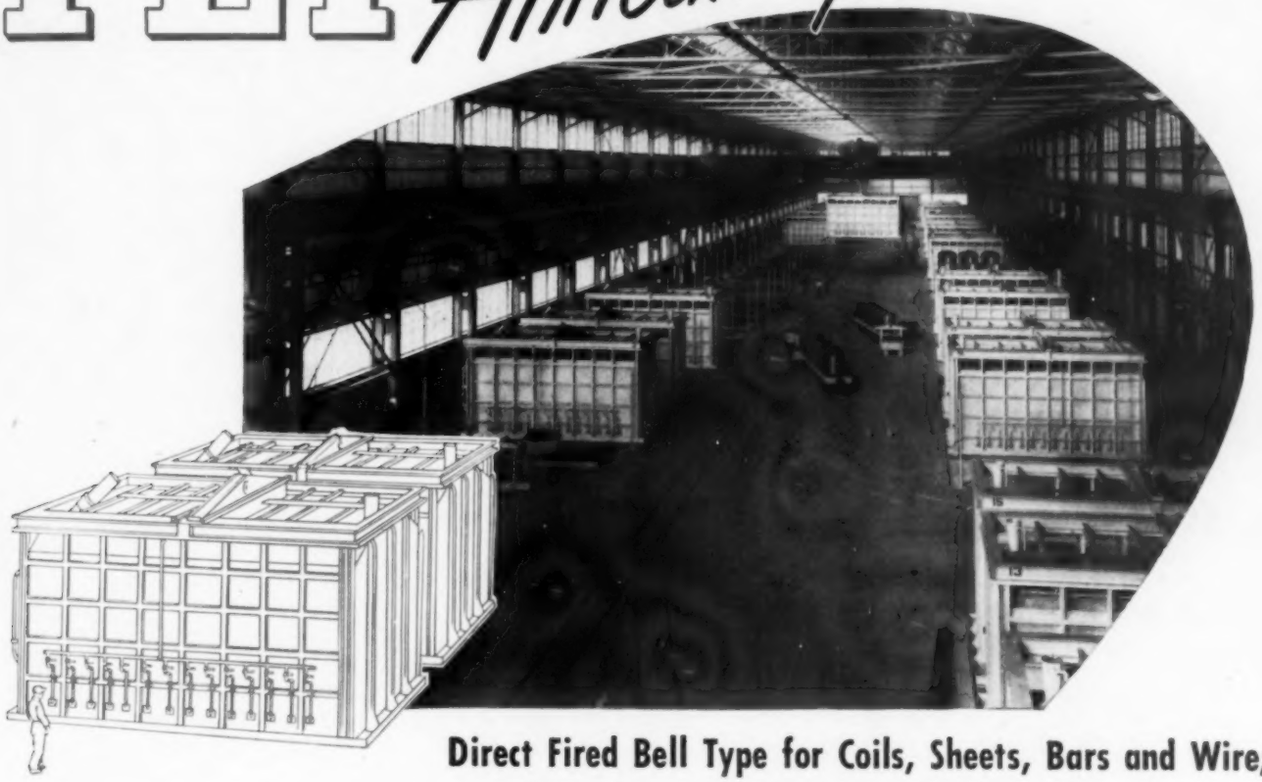
Ore bridges, electric melting furnaces and charging machines are "B" products. They include all wiring furnished by the erecting or fabricating contractor.

OBSOLETE MILL IS ADDED TO NATION'S SCRAP DRIVE

▲ A significant step in Wheeling Steel Corp.'s scrap recovery program is demolition of its obsolete No. 3 buttweld tube mill at the Benwood, W. Va., works, now under way. It is estimated by company officials that dormant scrap in the obsolete mill totals 120 tons, and that another 350 tons can be reclaimed from old railway equipment at the Benwood works.

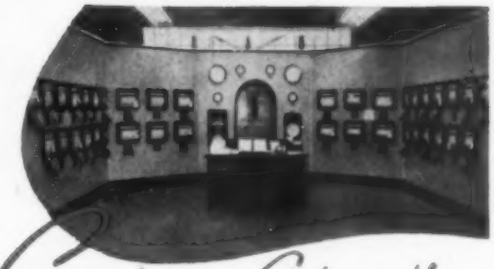
First placed in operation in 1910 to produce ⅛-in. and ¼-in. pipe, the mill now being dismantled was revamped in 1924 to produce ½-in. and ¾-in. pipe as well. The mill was completely rebuilt in 1936 and operated continuously until 1949, when it was rendered obsolete by completion of

F·E·I· *Annealing Furnaces*



Direct Fired Bell Type for Coils, Sheets, Bars and Wire; Complete Heating Lines for All Kinds of Armament: Guns, Armor Plate, Shells, Bombs, etc.

Fast! Efficient! Improved! F.E.I. Annealing Furnaces and Complete Armament Heating Lines are planned, engineered and built to do an outstanding job. Leaders of industry in America and abroad recognize Furnace Engineers' advanced heating methods, based on over thirty years' experience. F.E.I.'s patented, automatically controlled combustion system provides high metallurgical quality and economical operation. Consult us about improving YOUR plant's annealing performance—whether the need is for an entirely new installation or the modernization of existing furnaces.



Completely Automatic

- ***Easy to operate — even without previous experience.***
- ***Maintenance practically nil.***
- ***Minimum critical materials required.***

Photographs above show a battery of F.E.I. annealing furnaces in a large eastern steel mill; all furnaces are controlled automatically from a single Remote Control Room. F.E.I. also builds Open Hearth Furnaces, Soaking Pits, Continuous Reheating Furnaces, Forging Furnaces, and other heating lines.

Furnace Engineers, Inc.

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AFFILIATES — *Great Britain*, Salem Engineering Co., Ltd., Milford near Derby, England; *France, Belgium, Holland, Luxembourg and Italy*: Heurtey & Co., 38 Av. G. Mandel, Paris XVI, France.

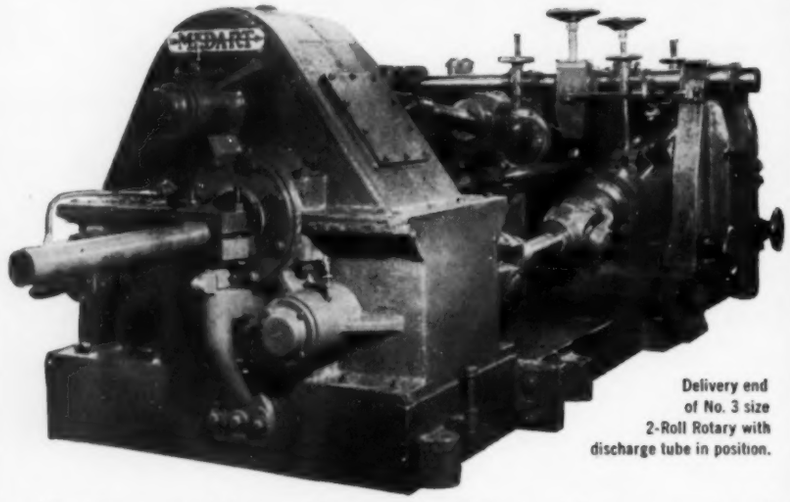
Continuous & Automatic End-to-End Straightening

...of round tubes and bars, 1/8" to 10" diameter, as short as 1"

MEDART

2-ROLL ROTARY STRAIGHTENER, SIZER & POLISHER

Single Motor Type—10 Different Sizes For All Requirements



Delivery end of No. 3 size 2-Roll Rotary with discharge tube in position.

- Precision straightens, sizes and polishes, and corrects out-of roundness, from end to end, on any round ferrous or non-ferrous workpiece
- Produces a more user-acceptable, uniform, improved finish on hot-rolled and pickled bars
- Puts a super finish on cold-drawn, turned and ground stock
- Removes mill scale from hot-rolled surfaces
- Improves the physical properties of the workpiece
- End-to-end feeding gives continuous, uninterrupted operation. Automatic feed-through and discharge
- Two-direction operation permits additional passes for sizing and polishing

Write For Complete Catalog

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MISSOURI

Old railway equipment at Wheeling Steel's Benwood works represents 350 tons of dormant scrap, now being reclaimed for production of new steel.

Wheeling's No. 2 continuous butt-weld pipe mill at Benwood.

Efforts of Wheeling Steel salesmen are also being coordinated by D. L. Irvine, assistant general sales manager, in a campaign to contact all industrial concerns and enlist their co-operation in scrap recovery on their own premises.

Recently Wheeling Steel's Steubenville works played host to a group of Ohio Valley farmers, organized by the Scrap Mobilization Committee in that area and county farm agents. The farmers were given an opportunity to see at first hand how scrap from worn-out machinery and tools is used in the production of open hearth steel.

The corporation's own scrap drive is in full compliance with the national effort sponsored by the Steel Industry Mobilization Committee and the Salvage Division of the National Production Authority. During 1951, 36,-200,000 tons of purchased scrap will have been consumed by America's steel industry. This is 6,700,000 more tons than were needed in 1950. As the industry strives for a new high in steel production in 1952, the shortage of scrap threatens to become more serious.

STAINLESS STEEL SHEATHES HEPPENSTALL BUILDINGS

▲ What is believed to be America's first "wrap around" stainless steel office building is rapidly taking shape in Pittsburgh, Pa.

The roof and all four sides of the four-story structure will be sheathed in stainless steel, except for door openings and a contrasting trim of colored tile at the base. The air-conditioned building will be windowless.

Research and Control-Testing

assure uniformly high quality of

Top—Precision equipment used in the Harbison-Walker Research Laboratories for accurate control studies.

The lower picture shows several of the many laboratory furnaces in which the refractories are tested.

HARBISON-WALKER
REFRACTORIES

The uniformly excellent service rendered by Harbison-Walker Refractories in a large measure is attributable to the planned program of scientific research development and careful control of processing during manufacture.

In the Harbison-Walker Research Laboratories, studies are constantly made of raw materials, finished products, and refractories which have been in service. These studies lead to improvements that result in longer life and better service from the refractories.

Uniformly high quality of Harbison-Walker Refractories is assured by the rigidly-maintained system of control testing. All products are checked at every step of manufacture to make certain that they measure up to the highest standards in every respect.

When you use Harbison-Walker Refractories, you are using the *best!*

HARBISON-WALKER LEADING PRODUCTS FOR METALLURGICAL FURNACES

BASIC REFRACTORY BRANDS

These nine separate classes fulfil every requirement

H-W PERIKLASE • H-W MAGNESITE
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FORSTERITE

SILICA BRICK BRANDS

STAR VEGA (Super Duty)

HIGH-ALUMINA BRANDS (Classes Shown)

H-W CORUNDUM 99% KORUNDAL 90%
CORALITE 80% ALUSITE 70%
ALCOR 60% ANCHOR 60%
DIALITE 50%

SUPER-DUTY FIRECLAY BRANDS

DEAN • BOONE • KENMORE
ALAMO • VARNON

Harbison-Walker Fireclay Refractories are available also in various High, Intermediate and Low Duty brands.

The complete line of Harbison-Walker Products also comprises all classes of Insulating Refractories, Acid-Proof Brick, Mortar Materials (acid, basic and neutral) both hot and cold setting, Plastics, Castables, Monolithic Ramming Materials and Bulk Refractories.

TRADE MARK
REG. U.S. PAT. OFF.

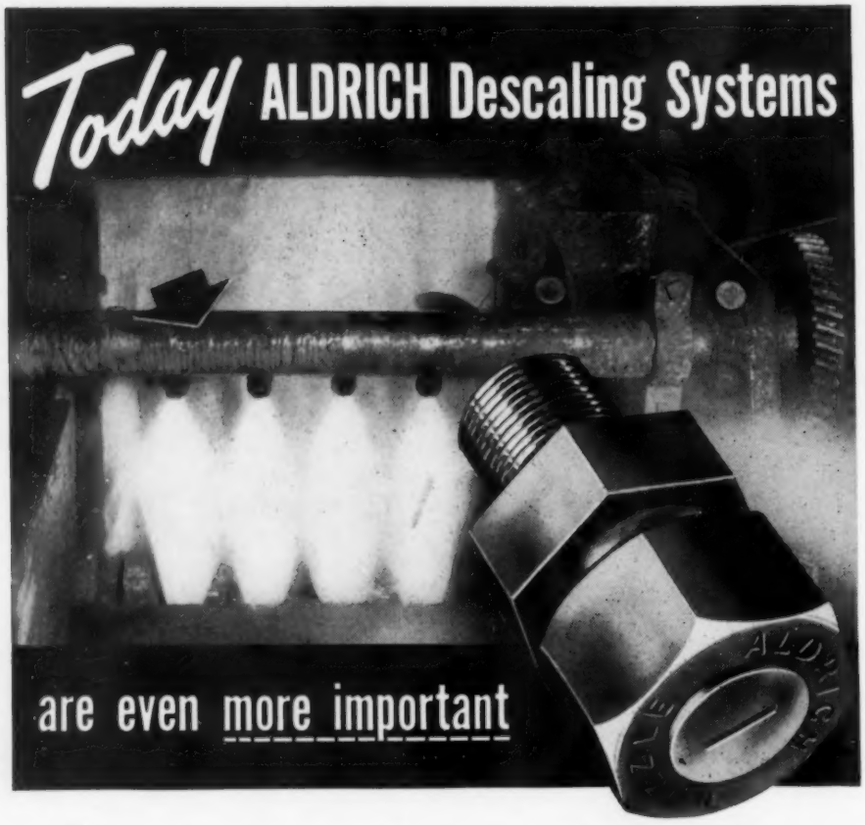
Harbison-Walker Refractories Company

AND SUBSIDIARIES

WORLD'S LARGEST PRODUCER OF REFRACTORIES

General Offices . . . . Pittsburgh 22, Pennsylvania

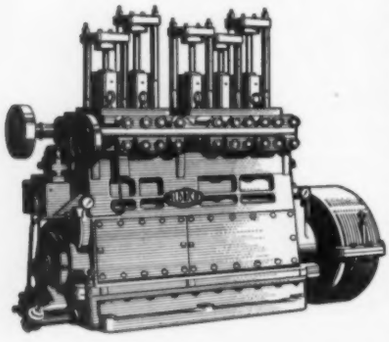
Today ALDRICH Descaling Systems



are even more important

Because the metal industries *need* peak production. And when it comes to descaling—an *Aldrich* system is the quickest means of getting the finish required.

Aldrich Spray Nozzles employ a Venturi tube, embodied in the body and disc, to direct flow through a *rectangular* orifice. This produces a knife-edged *line* of water with an impinging force equal to 95% of the potential energy supplied to the orifice. The sharp jet and the striking force developed by Aldrich nozzles give far more effective descaling than jets of equal force but with a larger impinging area, produced by more water at lower pressure . . . Aldrich Spray Nozzles are available from stock. *Write for Data Sheet 61-2.*



The Aldrich Pump for your system may be a Direct Flow Triplex or other Multiplex unit . . . fitted with Aldrich Patented Synchronized Suction Valve Control, or Automatic By-Pass Valve to operate with all types of accumulators. For your *complete* Descaling System, or for pumps for roll balancing or press operation: call on Aldrich! Write today for Data Sheets on equipment.

THE ALDRICH PUMP COMPANY

21 PINE STREET, ALLENTOWN, PENNSYLVANIA

. . . Originators of the Direct Flow Pump

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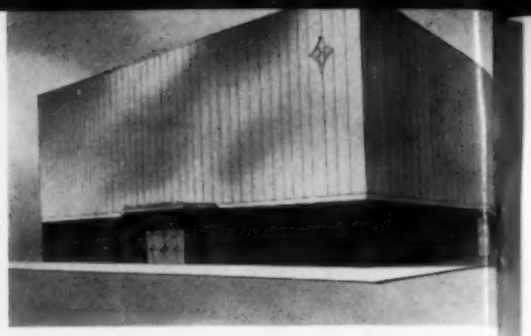


Photo murals and special painting and lighting will be used on interior walls to give an effect of distance.

Under construction for Heppenstall Co., steel forgings manufacturer, the building represents an enlargement and modernization of its two present office buildings, a four-story structure on Hatfield St., near 46th, and a three-story annex across a courtyard in the rear.

A new central unit, replacing the courtyard, will combine the present two buildings, previously linked only by an enclosed passageway. A fourth floor is being added to the annex to make its height uniform with that of the main building. Floor space will be increased approximately 30 per cent.

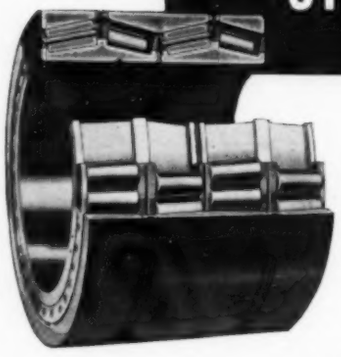
But even more noticeable will be the strikingly modern appearance of the building. The original exterior was of brick with limestone trim, and had dozens of windows. Already every window has been covered over, in preparation for placing the new trim of stainless steel and tile.

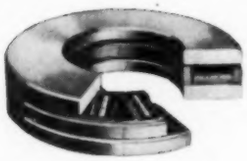
The tile, of a dark mottled texture resembling granite, will rise nine feet above the pavement and the stainless steel above that. There will be modern doorways at the front and one side. The only other openings will be at small balconies at the rear of each upper wall, necessitated for fire protection.

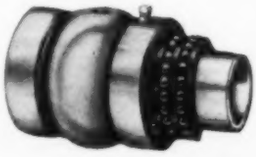
The entire building will be air conditioned and the amount of lighting will be increased to compensate for the loss of daylight. Large photo murals will be used on a number of the interior walls, and special painting on others.

RELIANCE ELECTRIC OPENS NEW EUCLID, OHIO, PLANT

▲ The new $1,800,000 Euclid, Ohio, plant of the Reliance Electric & Engineering Co. has been put into operation as 425 employees of the company's engineering, development, research, renewal parts and tool departments finally wound up the







Solving special friction problems is an everyday job with Torrington. Designing and producing made-to-order bearings has been an important part of our business for years.

This extensive experience has included all types of anti-friction bearings . . . both small and large . . . and for use in virtually every type of equipment. Result: Torrington can give you an impartial recommendation tailored to *your* application.

Whether you are a builder or user of machinery requiring bearings, Torrington engineers will gladly work with you in selecting a standard—or designing a special bearing tailored to your needs.

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TORRINGTON BEARINGS

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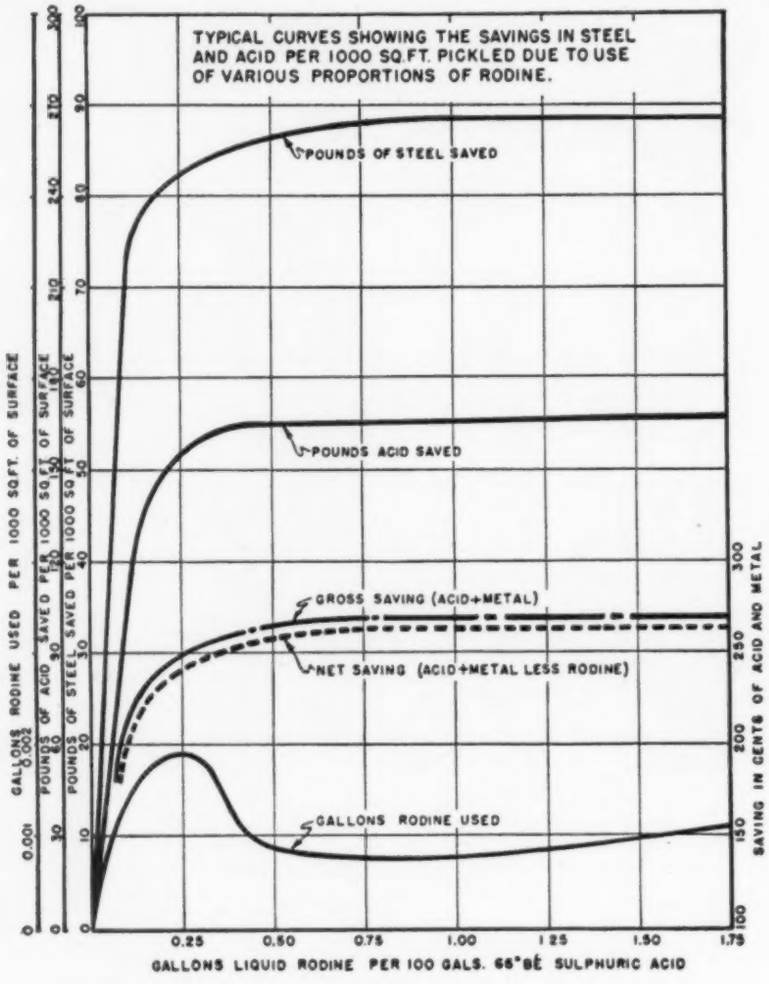
AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: EFFICIENT PICKLING WITH "RODINE"®

A. SAVINGS POSSIBLE WITH "RODINE"


TYPICAL CURVES SHOWING THE SAVINGS IN STEEL AND ACID PER 1000 SQ.FT. PICKLED DUE TO USE OF VARIOUS PROPORTIONS OF RODINE.
POUNDS OF STEEL SAVED
POUNDS ACID SAVED
GROSS SAVING (ACID+METAL)
NET SAVING (ACID+METAL LESS RODINE)
GALLONS RODINE USED
GALLONS RODINE USED PER 1000 SQ.FT. OF SURFACE
POUNDS OF ACID SAVED PER 1000 SQ.FT. OF SURFACE
POUNDS OF STEEL SAVED PER 1000 SQ.FT. OF SURFACE
SAVING IN CENTS OF ACID AND METAL
0.25
0.50
0.75
1.00
1.25
1.50
1.75
GALLONS LIQUID RODINE PER 100 GALS. 66°BÉ SULPHURIC ACID

B. TYPICAL APPLICATION OF "RODINE"

Pickling shell cases in uninhibited muriatic or sulfuric acid contributes to their embrittlement and makes it difficult to draw them without breakage. By adding a small amount of "Rodine" to the pickle bath, embrittlement is suppressed and more than enough acid is saved to pay the costs of the inhibitor.

CHEMICALS ACP PROCESSES WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM. CHEMICALS ACP PROCESSES

Specialized motor-drives for a wide range of industrial applications similar to the equipment shown here are among the products which the Reliance Electric & Engineering Co. is now making in its newly-opened, $1,800,000 plant at Euclid, Ohio. Here, Mrs. Ethel Mahan is shown completing electrical connections as W. R. Metzger (left) and Marvin R. Stein (center) observe.

strenuous, two-week job of moving into the new facility from the firm's two plants on East 152nd St., Cleveland, Ohio.

The new plant is located at 24701 Euclid Ave. on a 65-acre plot paralleling the Nickel Plate Railroad right-of-way for 2000 ft immediately east of the Tapco Plant near Babbitt Road. It is accessible from Euclid Ave. in the 24700 block.

Built in nine months at a cost of approximately $1,800,000, which includes certain production equipment and related service facilities, the plant is a single-story structure 442-ft long and 352-ft wide with a total floor area of 133,000 sq ft.

Off-street parking space, capable of accommodating 350 cars at one time, is located immediately adjacent to the plant.

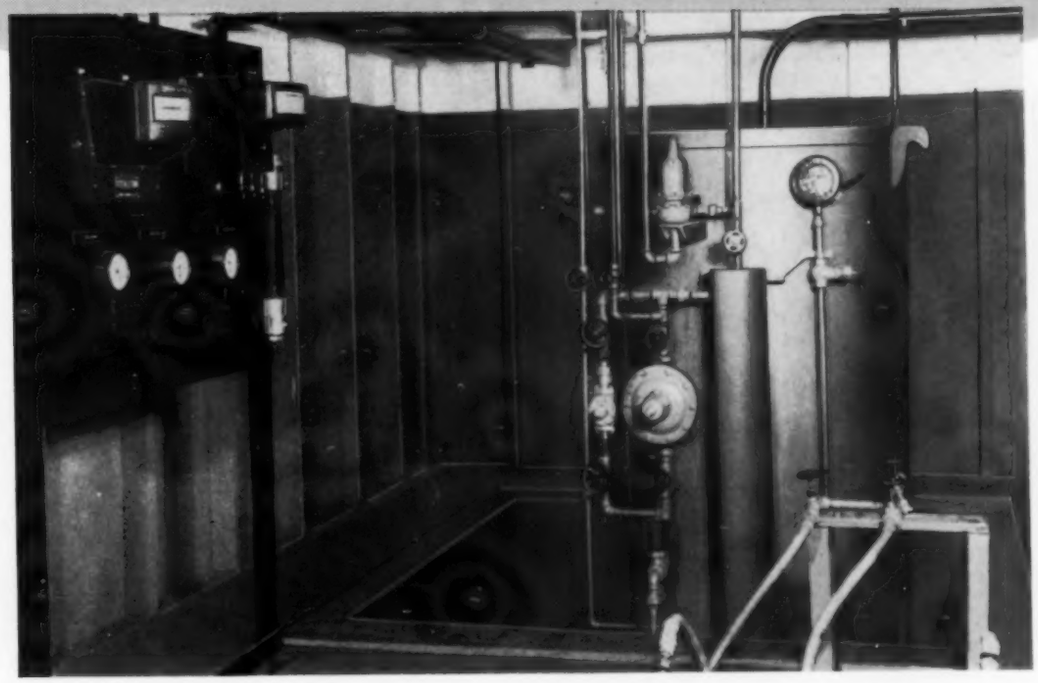
Replacing two plants on East 152nd St. to be released to the Clark Controller Co. whose factory they adjoin, Reliance's new Euclid plant is similar in basic architectural and construction essentials to a plant of approximately the same size built by the company in Ashtabula in 1947 for the manufacture of electric motors.

The new plant enables Reliance to conveniently centralize a number of its technical functions and facilities under one roof at a single location. These include engineering, research and development laboratories; the manufacture of electronic equipment and motor drive controls; renewal parts and customer service activities,

DREVER

AMMONIA DISSOCIATOR

produces **the ideal protective furnace atmosphere**



Shown at right is Drever 1000 CFH Ammonia Dissociator — panel complete with flow meter, pressure gauge, over-temperature protection instruments and temperature control, which is now furnished flush mounted.

"CRACKED" AMMONIA SHOWS TREMENDOUS COST SAVING and UNSURPASSED PERFORMANCE

1 —Bright Annealing — Stainless Steels, Nickel and Nickel Alloys, Beryllium Copper, Silicon Copper Alloys and Bronzes, and high and low carbon steels.

2 —Clean Hardening — High carbon and high chrome tool steels.

3 —Copper Brazing of all types of ferrous metals.

4 —Sintering of Powdered Metal Parts.

5 —Reduction of Metal Oxides.

6 —Bright Annealing of Electrical Steels.

7 —Atomic Hydrogen Welding.

8 —Radio Tube Sealing.

We can supply COMPLETE STORAGE SYSTEMS for tank car lots of anhydrous ammonia. This reduces the cost of ammonia approximately 75%.

GET ALL THE FACTS about dissociated ammonia, pure, dry hydrogen and nitrogen. **Write today for Bulletin B-52 now on the press.**

DREVER CO.

730 E. VENANGO ST., PHILADELPHIA 34, PA.

TM Alloy Steel CHAINS

DO MORE WORK, LAST LONGER, COST LESS . . . THAN WROUGHT IRON TYPES

This Registration Ring bears the chain's serial number and safe working load. It's your assurance of thorough testing and inspection.

Your chain problems are substantially reduced when you buy TM Alloy Steel Chain. Records prove this famous chain *outlasts* and *outperforms* wrought iron types . . . even under the toughest conditions. It's more economical too!

TM Alloy Steel Chain has twice the tensile strength. Controlled heat-treatment assures a uniform hardness of from 265 to 285 Brinell. These features make it highly resistant to abrasion, cold-working, grain growth and shock at all temperatures.

Send for free booklet containing all the facts and specifications on TM Alloy Steel Chain and attachments.

S. G. TAYLOR CHAIN COMPANY
Dept. 5, Hammond, Indiana
Rush literature and prices on TM Alloy Steel Chains.

NAME_____

ADDRESS_____

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

and the design, development and manufacture of specialized tools required by the company's other plants.

ALLEGHENY LUDLUM BUYS ALLEGHENY RIVER SITE

▲ Allegheny Ludlum Steel Corp. has purchased the 160-acre industrial site known as "Murphy's Flats" on the west bank of the Allegheny River three miles north of Freeport, Pa.

The site, situated about twelve miles from the company's Brackenridge plant and also easily available to its West Leechburg plant, was bought for future expansion of the company in the Pittsburgh district. E. J. Hanley, president of Allegheny Ludlum, said that the purchase has been made with a view to providing for future expansion and was deemed desirable since company properties at Brackenridge and West Leechburg are almost completely occupied.

The land was bought from two companies, Allegheny River Mining Co. and Pittsburgh & Shawmut Railroad Co. It is a level tract lying between the river and the main line of the Pittsburgh & Shawmut Railroad and is situated above the high water level of the river. The southern portion of the tract is wooded and the balance is farmland.

GERRARD STRAPPING MOVES PLANT IN SOUTHERN U. S.

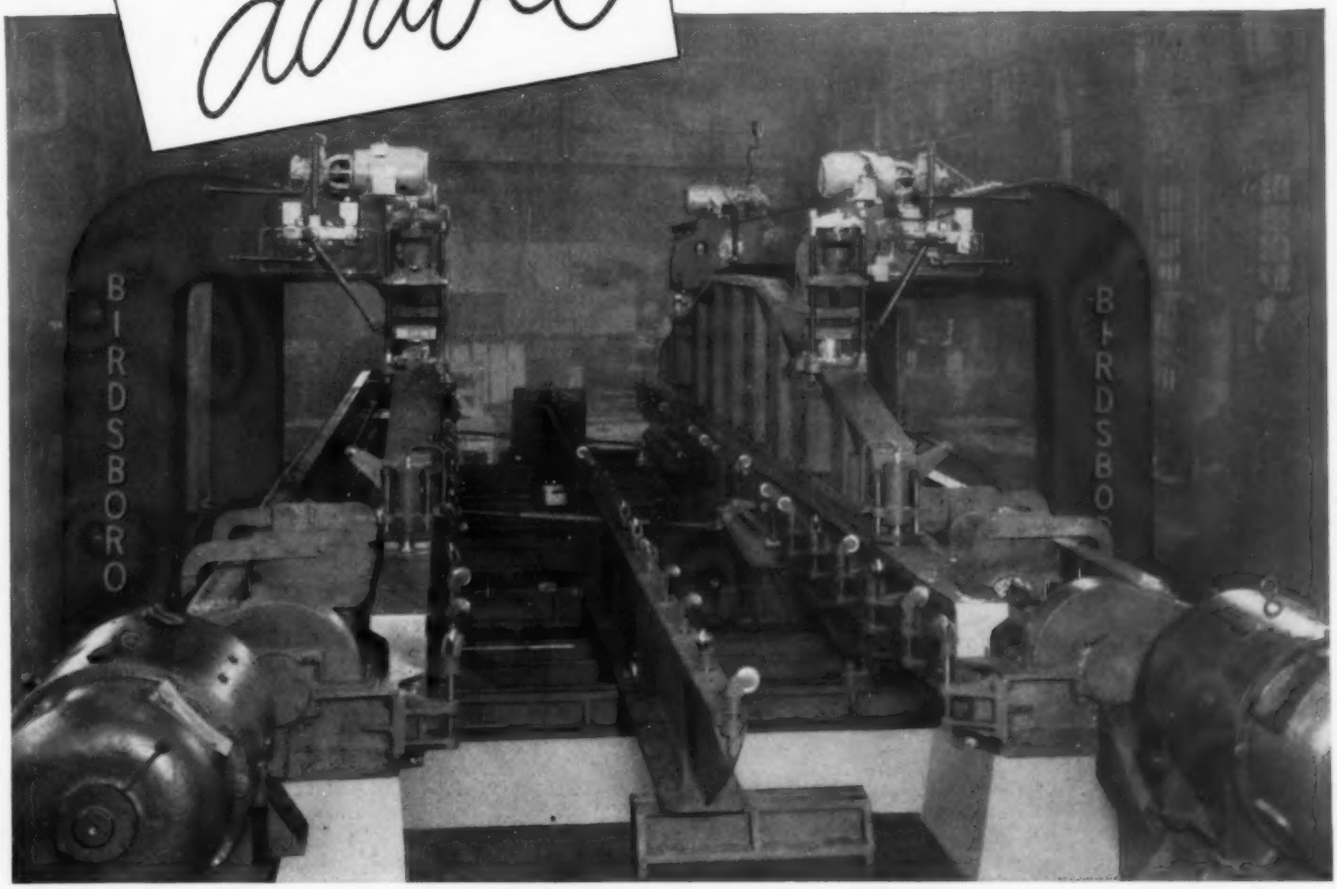
▲ Gerrard Steel Strapping Co., a United States Steel Corp. subsidiary, announced that its southern division plant and offices would be transferred from New Orleans, La., to Birmingham, Ala. The company will occupy the old Pittsburgh Plate Glass Co. building at Ninth Avenue and 20th Street, North.

The Tennessee Coal, Iron and Railroad Co., southern steel producing subsidiary of United States Steel, was largely instrumental in arranging the transfer to Birmingham.

The southern division office of the company was established in New Orleans in 1927 to serve principally the citrus industry and box and shook manufacturers. In the intervening years, it has extended its services to include a wide variety of consumers, and now handles a sizable portion of the south's requirements for tying wire and strapping.

The move to Birmingham is being made to achieve greater proximity to

DOUBLE *double* YOUR PRODUCTION...



with this Birdsboro Plate Planer

Two edges are planed in one pass with one setup at speeds up to 100 ft. per min. This is a time-saving advantage over most other machines which require two passes to machine a plate edge.

Such increased production is essential to speed the production of welded pipe and the laying of pipe lines so necessary in our defense effort.

This Birdsboro Plate Planer is equipped with a mechanical centering device which guides the plates over the casters. A self-contained hydraulic system locks the plates in place under heavy hold-down beams.

If you are considering installing any type of steel mill machinery, it will pay you to enlist the services of Birdsboro engineers.

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

Offices in
BIRDSBORO, PA.
AND PITTSBURGH, PA.

STEEL MILL MACHINERY

Designers and Builders of:
Steel Mill Machinery • Crushing Machinery • Rolls
Hydraulic Presses • Special Machinery • Steel Castings

MM-23-52

its sources of supply, to provide a majority of its customers with faster and more economical service, and to provide facilities for future expansion.

INSTRUMENT FIRM HOLDS SCHOOL IN PHILADELPHIA

▲ The first courses in instrument maintenance and repair to be held in 1952 by the Brown Instruments division of Minneapolis-Honeywell Regulator Co. started on January 7. They are being held in the Brown School at Philadelphia, Pa.

As in the past, a large part of the six months of training for the second semester of the 1951-52 season will be for the benefit of Honeywell customers' men. Other periods will be held for the training of Honeywell men who will be assigned to field sales and service staffs upon successful completion of the courses.

The schedule, M. J. Ladden, chief instructor, said, will be divided into study periods of varying length including a 13-weeks comprehensive course that will extend from February 11 to May 9. Other courses will be held from January 7 to June 27. It is expected that special courses will be held for government engineers, including those from the AEC, from educational institutions and from various friendly nations. During 1951 the company maintained instruction for similar groups for practically the entire year.

The coming schedule will include studies in pyrometry and electronic potentiometers, pneumatic control and transmission, flow meters, thermometers, pressure gages, and hygrometers, millivoltmeter type pyrometers, electrically operated automatic control, Moist-o-Graphs, tachometers, resistance thermometers and analygraphs.

YORK BUYS FACILITIES FOR MACHINE SHOPS

▲ York Engineering & Construction Co., Pittsburgh, Pa., has announced the purchase of the plant and manufacturing facilities of the Gillespie Manufacturing Co., located at 810 Brocket St. in Pittsburgh. The York-Gillespie Manufacturing Co. has been formed to operate the plant and will engage in the design and manufacture of special custom-built machinery and auxiliary equipment for steel mills and other industrial plants.

Charles MacGregor has been elected president; James MacGregor, vice president; J. Donald Cook, secretary; and Philip M. Weber, treasurer, of the York-Gillespie Manufacturing Co.

COAL CONSUMERS FORM MATHIES COAL CO.

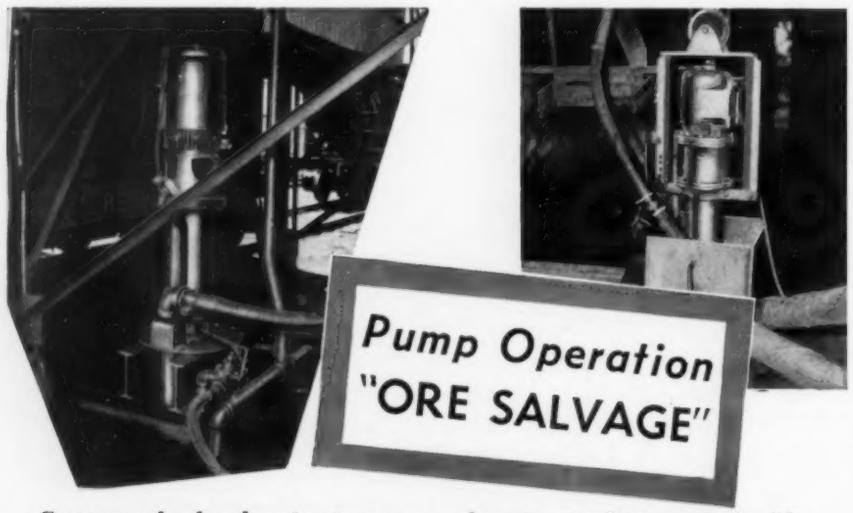
▲ Three large coal consumers—National Steel Corp., Steel Co. of Canada, Ltd., and Youngstown Sheet & Tube Co.,—are joining with Pittsburgh Consolidation Coal Co. to form the Mathies Coal Co.

This was done by the steel companies for the purpose of increasing their reserves of metallurgical coal and to avoid the present high capital costs of developing new mining operations to meet their increased coal needs. With respect to Pittsburgh Consolidation, it was pointed out that this transaction was in line with the company's announced intention to make continuing long-term arrangements with some of its major customers. The same sort of joint arrangement is very common in iron ore operations and is a natural evolution in coal mining as this industry becomes more highly mechanized, involving greatly increased capital costs.

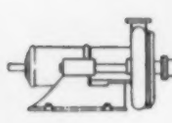
INDUSTRIAL SERVICE IS OFFERED BY NEW FIRM

▲ Formation of the Heppenstall Industrial Service Co. has been announced. The new firm will serve as a consultant in the application and installation of modern techniques in the forging, steel processing, steel fabricating and paper industries. Specializing in modern production processes, the company will have its headquarters in the Frick Building in Pittsburgh, Pa.

Founder and president of the new firm, C. W. Heppenstall formerly was vice president in charge of operations for Heppenstall Co., a producer of forgings, shear knives and die blocks. Mr. Heppenstall was responsible for the introduction in this country of



SPILLAGE of value-bearing iron ore wash water results in considerable loss in car loading operations like these, on the Missabi Iron Range. It also causes messy conditions for the operators. Nagle type "SW-OB" pumps with no stuffing box and no submerged bearings recircuit these waters from spillage collecting sumps to further processing and keep the area dry and clean. The job is dirty, gritty, abrasive — no job for any but the toughest pumps. Job-tailored abrasion resistant water-end parts and maintenance that is a marvel of simplicity are just two of the many reasons why more gruelling pumping jobs are handled by Nagles. Write for the Nagle solution to your most abrasive or corrosive application, whether it calls for vertical or horizontal pumps.



Nagle Pumps INC.

INDUSTRIAL PUMPS FOR ABUSIVE APPLICATION

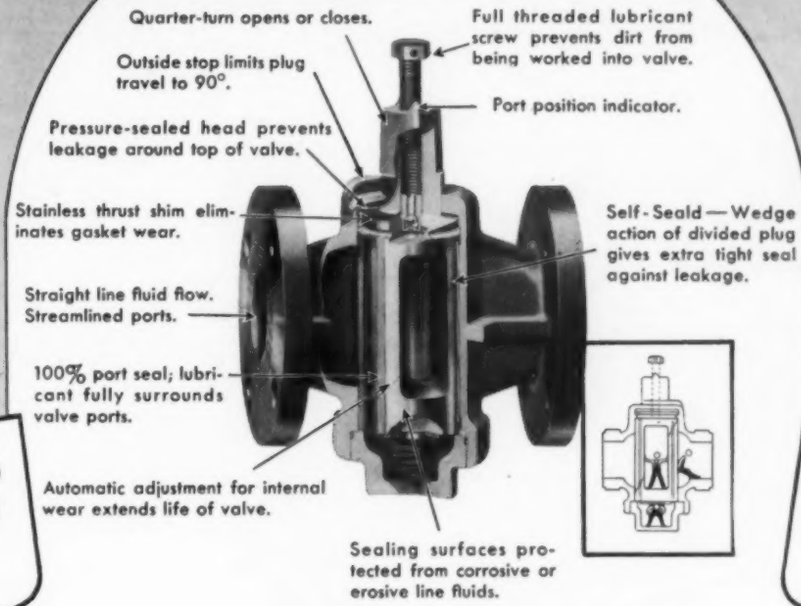
1263 CENTER AVENUE, CHICAGO HEIGHTS, ILLINOIS

We Make ALL Types of PLUG VALVES

ONE OF THEM IS THE RIGHT VALVE FOR YOUR NEEDS

HOMESTEAD-REISER "Self-Seald" LUBRICATED PLUG VALVES

Straight-way—
Worm & Gear Operated


Quarter-turn opens or closes.
Full threaded lubricant screw prevents dirt from being worked into valve.
Outside stop limits plug travel to 90°.
Port position indicator.
Pressure-sealed head prevents leakage around top of valve.
Stainless thrust shim eliminates gasket wear.
Self-Seald—Wedge action of divided plug gives extra tight seal against leakage.
Straight line fluid flow. Streamlined ports.
100% port seal; lubricant fully surrounds valve ports.
Automatic adjustment for internal wear extends life of valve.
Sealing surfaces protected from corrosive or erosive line fluids.

Flow Changer—
Non-lubricated

HOMESTEAD CAM-SEALD
(dry seat)

HOMESTEAD LEVER-SEALD
(quarter turn)

How the Amazing "Self-Seald" Principle Works

Homestead-Reiser's patented "Self-Seald" principle is, we believe, the simplest and most effective sealing principle yet developed for lubricated plug valves.

In addition to a full lubricant seal around the ports, and around the top and bottom of the valve, the wedge-action of the divided plug under line pressure, causes the finely-finished surfaces of both segments of the plug to press outward against the sealing surfaces of the body.

This self-sealing action keeps the plug surfaces in contact with the mirror-like bore of the body. The plug automatically adjusts itself for wear, thus assuring extra long life and maximum leakless service.

For complete information, sizes and prices, write for Catalog 39-5. No obligation.

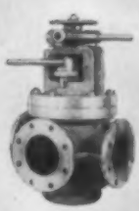
Straight-way—
Flanged or Screw Ends

Straight-way—
Flanged or Screw Ends

Three-way—
Screw or Flanged Ends

Four-way—
Flanged or Screw Ends

Four-way— Flanged or
Screw Ends



Three-way— Flanged or
Screw Ends

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 21 *"Serving Since 1892"* CORAOPOLIS, PA.

two German-perfected production techniques. They are: a high speed trepanning technique, used for trepanning large gun barrels; a method of contour forging breech rings for guns. From the British and the French, he introduced the production use of an immersion thermocouple to take liquid bath temperatures in acid open hearth, electric arc and high frequency induction furnaces.

FARREL-BIRMINGHAM BUYS ROCHESTER, N. Y., PLANT

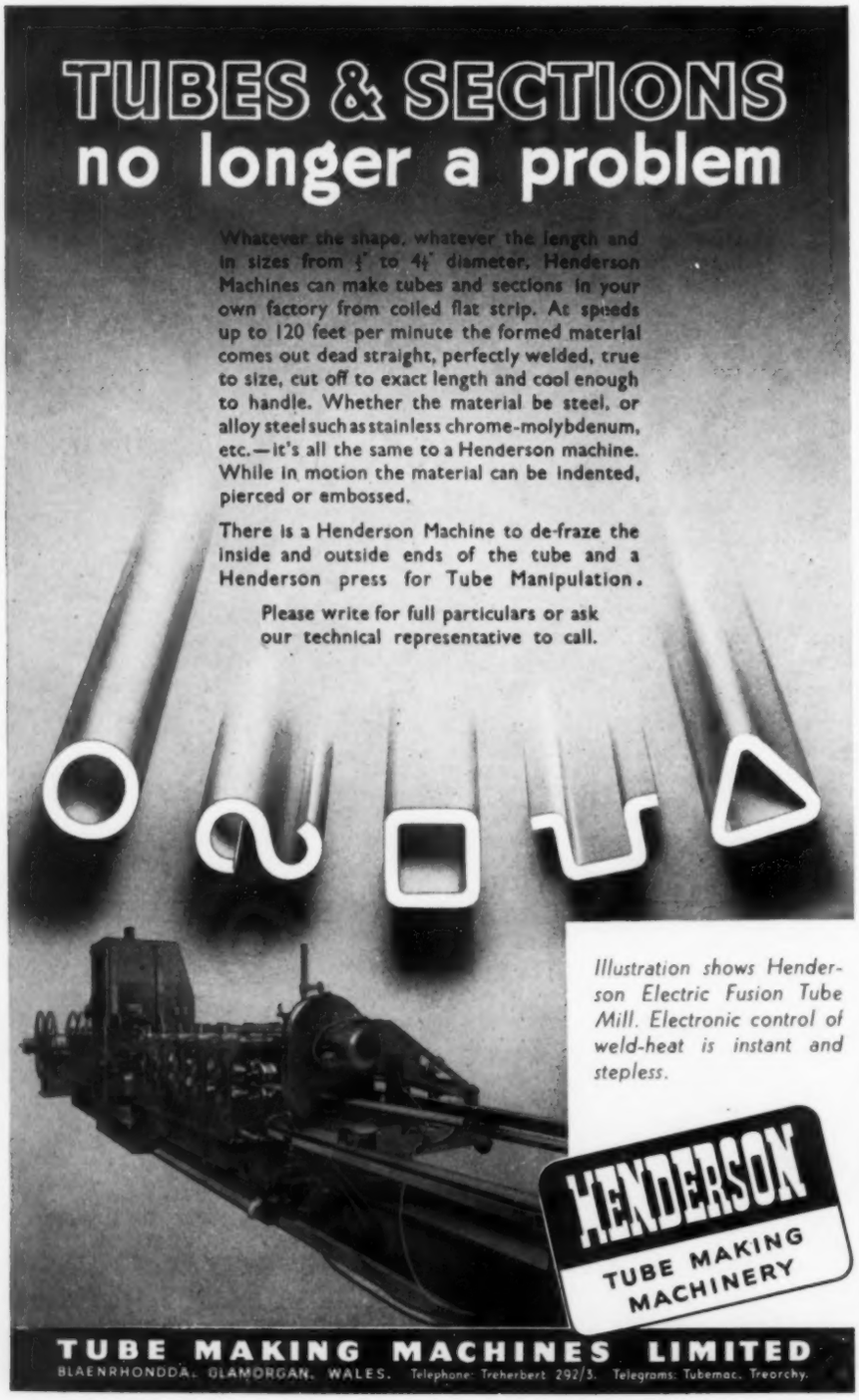
▲ Farrel-Birmingham Co., Inc., of Ansonia, Conn., has acquired the common stock of Consolidated Machine Tool Corp., Rochester, N. Y., part of the consideration being securities of Farrel-Birmingham Co. The Consolidated plant will be operated as a subsidiary of Farrel-Birmingham and will continue production of its well established machine tool lines.

BATTERY FIRM SPONSORS EDUCATIONAL SHOW

▲ The Industrial Battery division of Gould-National Batteries, Inc., Trenton, N. J., is producing a one-hour-long Broadway-type show which will tour large industrial cities early in 1952. The review, entitled "Gould Nuggets of 1952," comprises a series of entertaining carnival acts explaining Gould's new plus performance plan.

Invited to attend will be plant superintendents, supervisory personnel, materials handling engineers, maintenance men, purchasing agents, battery-room supervisors, and others concerned with the care and maintenance of industrial storage batteries and equipment operated by batteries.

The underlying reason for the program is, of course, to teach industry how to get maximum capacity from its equipment and extend its life. This objective, of tremendous importance at all times, has an even greater impetus today because of the serious shortages of lead and other battery materials. In addition, industry is demanding a much larger volume of batteries, particularly in the materials handling and railroad fields.


TUBES & SECTIONS
no longer a problem
Whatever the shape, whatever the length and in sizes from ½" to 4½" diameter, Henderson Machines can make tubes and sections in your own factory from coiled flat strip. At speeds up to 120 feet per minute the formed material comes out dead straight, perfectly welded, true to size, cut off to exact length and cool enough to handle. Whether the material be steel, or alloy steel such as stainless chrome-molybdenum, etc.—it's all the same to a Henderson machine. While in motion the material can be indented, pierced or embossed.
There is a Henderson Machine to de-fraze the inside and outside ends of the tube and a Henderson press for Tube Manipulation.
Please write for full particulars or ask our technical representative to call.
Illustration shows Henderson Electric Fusion Tube Mill. Electronic control of weld-heat is instant and stepless.
HENDERSON
TUBE MAKING MACHINERY
TUBE MAKING MACHINES LIMITED
BLAENRHONDDA, GLAMORGAN, WALES. Telephone: Treherbert 292/3. Telegrams: Tubemac, Treorchy.

RYERSON ACQUIRES WEST COAST WAREHOUSES

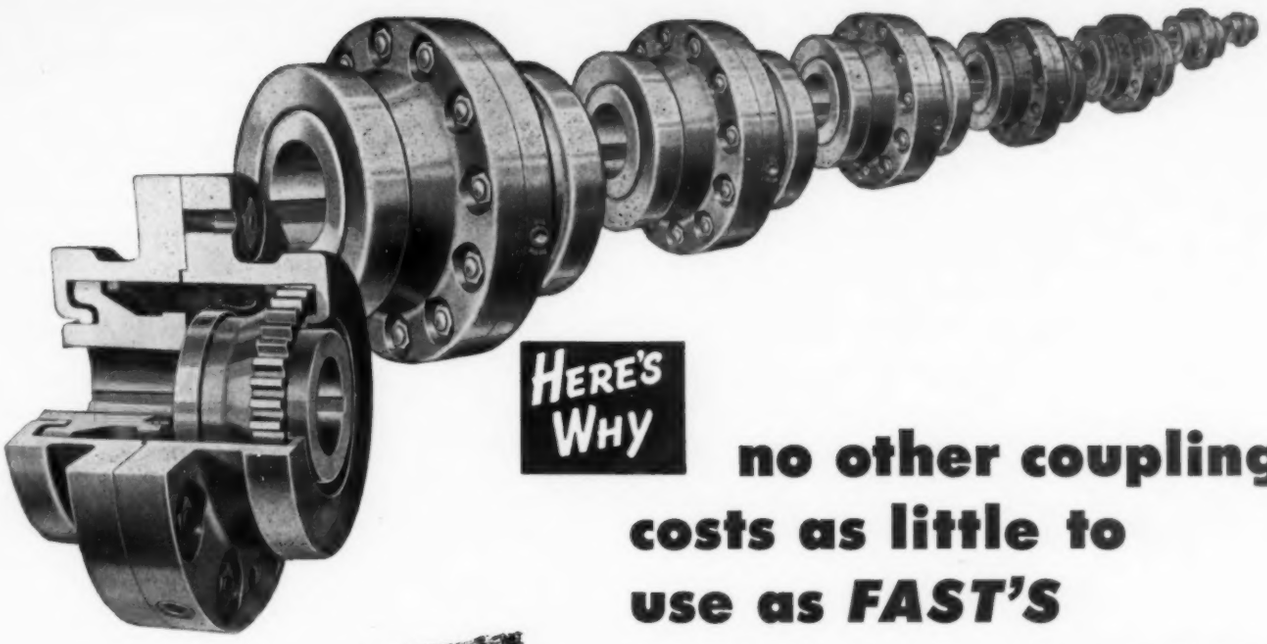
▲ Joseph T. Ryerson & Son, Inc., well known steel distributor, acquired the stocks and warehouse facilities formerly owned by the Seattle Steel Co., of Seattle, Wash., and the Inland Empire Steel Co., of Seattle and Spokane.

Although stocks have been unbalanced, Seattle Steel Co. carried a large tonnage of carbon, alloy and stainless steel in bars, structurals, plates, sheets and tubes; also brass, bronze, copper, aluminum and other products.

TITANIUM COMPANY MOVES OFFICES TO NILES, OHIO

▲ Mallory-Sharon Titanium Corp. has moved its general offices from Indianapolis, Ind., to Niles, Ohio. Mallory-Sharon is a jointly owned company formed by the P. R. Mallory & Co., Inc., and Sharon Steel Corp. earlier this year for the melting and fabrication of titanium and its alloys.

The corporation was formed to pool the years of research and devel-



HERE'S WHY

no other coupling costs as little to use as FAST'S

With Fast's Couplings you get the lowest coupling cost per year that modern engineering can provide—*because Fast's normally outlast the equipment they connect.* That means their cost can be spread out over 20 years or more!

As two users recently said:

"We've had this Fast's Coupling since 1930 . . . and it's apparently going to last forever. [Wish] the other equipment caused as little trouble!" . . . "We have two Fast's Couplings . . . they are the only equipment so trouble-free we long ago forgot we had them!"

If you want lower costs, freedom from coupling shutdowns and dependable coupling engineering—specify Fast's. For complete details, mail the coupon for Fast's free catalog. Do it today!

RUGGED CONSTRUCTION:

Fast's still maintains its original design, without basic change or sacrifice in size or material. This assures you freedom from needless and expensive coupling failures.

FOOLPROOF DESIGN:

Instead of perishable oil seals, Fast's Couplings use a permanent metal-to-metal closure to keep dust out and oil in. Oil is always maintained at a safe level whether the Fast's is running or standing still.

FREE SERVICE:

When you specify Fast's Couplings you get Koppers' valuable free coupling service. If your application seems to need a special coupling, Koppers' engineers in many cases can easily modify a standard Fast's Coupling, and save you money!

MAIL COUPON TODAY FOR FREE CATALOG!

KOPPERS CO., INC., *Fast's Coupling Dept.,*
211 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

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KOPPERS

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

INDUSTRY'S STANDARD FOR 31 YEARS

opmental work carried on by P. R. Mallory in the field of titanium with the melting, rolling and fabricating facilities of Sharon Steel and Niles Rolling Mill Co.

It was also stated by the company that the titanium melting furnace now located in Indianapolis is being moved to Niles. Three new furnaces to be installed at Niles will bring available titanium melting capacity at Mallory-Sharon to two million pounds in 1952. Also, during 1952 the laboratory, engineering, and research work on titanium now being carried out in Indianapolis will be established in Niles.

The headquarters of the company will be at the Niles Rolling Mill Co. plant in Niles, Ohio, one of Sharon Steel's subsidiary companies which has carried on development work on the rolling and fabricating of titanium.

SULPHUR SHORTAGE WILL BE WORSE DURING 1952

▲ The world shortage of sulphur, which became pronounced as 1951 wore on, will become worse in 1952 as the rearmament program of the United States and its allies gains momentum, Langbourne M. Williams, Jr., president of Freeport Sulphur Co., predicted.

Despite record production by the American brimstone industry, the discovery of a large new deposit and projects to develop three others, "any significant increase in the overall supply of sulphur is at least a year away," Mr. Williams said in an appraisal for the new year.

U. S. production of sulphur in all forms in 1951 totaled approximately 6,200,000 long tons. Of this amount, it is estimated that 5,325,000 tons was elemental sulphur or brimstone from Gulf Coast salt dome deposits, 200,000 tons was brimstone recovered from refinery and sour natural gases, 400,000 tons was sulphur in pyrites, and the remainder was sulphur obtained in other forms from smelter gases and other sources. Production in 1950 approximated 6,000,000 tons.

While production for 1951 was sufficient to fill domestic needs, it was not enough to meet both domestic and export demand. Government-directed exports to friendly nations took almost 25 per cent of Gulf Coast brimstone production. As a result, major brimstone producers were compelled to resort to allocation programs to domestic consumers.

Exports of crude sulphur in 1951 amounted to approximately 1,300,000 long tons or almost 95 per cent of the 1950 total. The United Kingdom was the recipient of the largest allocation. Its quota was approximately 400,000 tons compared with 420,000 tons in 1950.

ACME STEEL ORGANIZES STRAPPING DIVISION

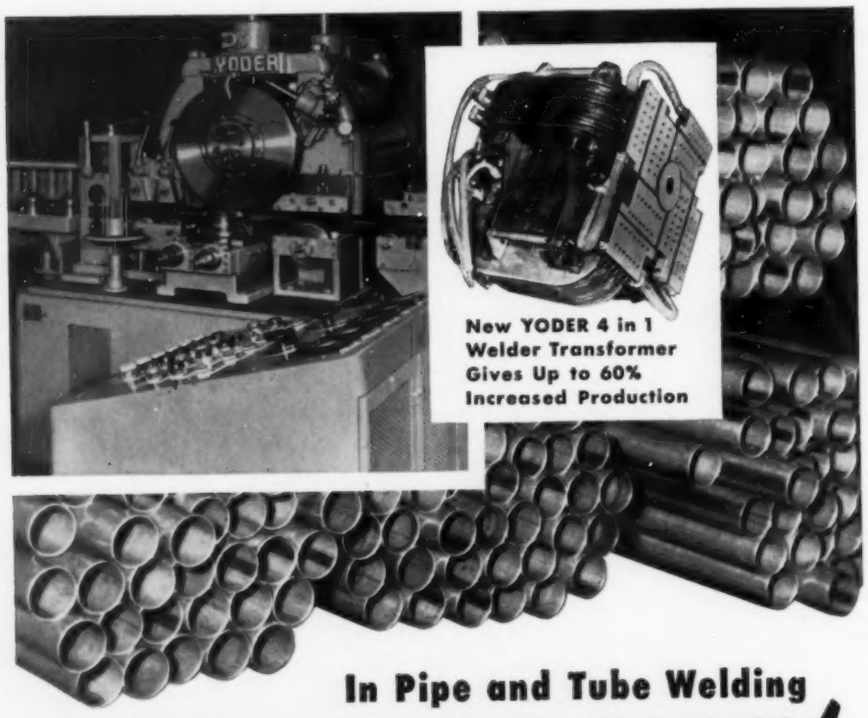
▲ The formation and organization of Acme Steel Products division of Acme Steel Co., Chicago, Ill., has been announced.

The new division will operate and function, effective January 1, 1952, as an independent sales and distributing company for steel strapping, tools and accessories, stitching wire and equipment, as well as other related industrial strip steel products. Previously, these products were sold through the company's internal consumer products division. Sales of strip steel and special products will remain with the parent company as will all manufacturing and production operations.

INSTRUMENT COMPANY OPENS HARRISBURG OFFICE

▲ A new district office has been opened at Harrisburg, Pa., by Minneapolis-Honeywell Regulator Co.

The new office, located in the Kline Village development, was made necessary, Honeywell officials said, by an increasing demand in the Harrisburg area for process measuring and



In Pipe and Tube Welding

YODER SCORES AGAIN!

● Since the introduction of the Yoder electric resistance weld Tube Mills in 1939, nothing quite so important has happened as the new **Yoder four-in-one Welding Transformer.** Instead of the conventional single rotating transformer, it embodies four smaller transformers surrounding a common core, making a unit of unique compactness and strength which insures longer life and fewer interruptions for servicing. Equally important—impedance is reduced, resulting in higher electrical efficiency.

Compared with the present Yoder welder, production gains up to 20% are recorded. Compared with other tube welders, the gain may be as high as 50% to 60%. All Yoder tube mills henceforth will be equipped with this transformer. It is also available for replacement of welders in other tube mills. *Literature, recommendations and estimates for the asking.*

THE YODER COMPANY • 5497 Walworth Ave., Cleveland 2, Ohio

Complete Production Lines

★ COLD-ROLL-FORMING and auxiliary machinery
★ GANG SLITTING LINES for Coils and Sheets
★ PIPE and TUBE MILLS—cold forming and welding

ENGINEERING YODER MANUFACTURING

LINDE'S News of Metalworking

Braze-Welded Repair Saves Six Months' Production Time

When the base of a 5-ton alligator shear cracked in service, early return to normal plant operation appeared hopeless. Delivery of a new shear was six months away . . . cost $1,800.

But LINDE service engineers suggested braze-welding. Within a few days the shear was back in service—permanently repaired at a cost of only $355. This single braze-welding job saved the manufacturer $1,445 and six months of valuable production time.

Similar typical savings account for widespread industrial acceptance of braze-welding as a quick, easy way to join steel, cast iron, malleable iron, and many dissimilar metals. And routine repairs by braze-welding are often made without dismantling machines. Shut-down time is always kept to a minimum.

Why not save the cost, delivery, and installation time required for that new part? Put the old one back on the job with braze-welding.

Braze-welding is only one of many time- and moneysaving LINDE methods for making, cutting, joining, treating, and forming metals. For further information, call or write our nearest office today.

Replacement of this $1,400 ring gear would have taken more than six months. Braze-welding at half the cost rebuilt badly worn teeth and restored the gear to service in just a few days.

What's News

► One steel company has found their OXWELD C-60 Cutting Blowpipe so effective in reducing large pieces of scrap that they are now purchasing quantities of large-size scrap to process themselves.

► Saran and polystyrene, previously resistant to speedy pulverization, are now being successfully ground by LINDE'S new liquid nitrogen pulverization method. . . . Efficiency is such that the new process pulverizes some previously difficult-to-grind materials at rates over 700 lb. per hr.— using small mill hammers.

► Magnesium hydraulic systems for landing gears were formerly discarded at an airplane shop when pinhole leaks appeared. Now, thanks to HELIARC welding they're repaired at a saving of $500 each.

"LINDE" SERVICE DOESN'T COST — IT PAYS!

LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

"Irreplaceable" Cylinder Back at Work in 20 Hours

It looked as if "old faithful" was headed for the scrap pile when overworked pistons snapped and cracked the cylinder of a 1904 model railroad locomotive. To replace the cylinder would have been next to impossible. But braze-welding had "old faithful" back at its lumber mill job in only 20 hours.

Repairs were made without dismantling. After the crack was prepared for welding, the cylinder was covered with asbestos paper and preheated. Then the crack was welded, and the cylinder rebored. Total preheating and welding time was 13 hours.

Repairs cost only $138, including materials, labor, and overhead. Even if the cylinder could have been replaced—at a cost over $4,000—the locomotive would have been idle many months instead of the few hours required to make the repair.

Rapid repair of unavailable or hard-to-get parts is a natural job for braze-welding. Try it yourself, next time you're bothered with a troublesome replacement problem.

Braze-welding this locomotive cylinder without dismantling saved a lumber company more than $4,000. On special jobs like this, LINDE service and supervision assures success.

The terms "Heliarc," "Linde," and "Oxweld" are registered trade-marks of Union Carbide and Carbon Corporation.

controlling instruments and for heating and commercial controls.

William J. Brosch and Jack Caylor will handle sales for the company's Brown Instruments division. John Hopkins will handle commercial, and Donald Schmick heating controls divisions sales.

BEARING SPECIALISTS FORM TRADE ORGANIZATION

▲ A new trade organization of national scope, to be known as the Association of Bearing Specialists, has been incorporated under the laws of the State of Illinois it was announced by William F. Chase of the Bearing Service Co., Pittsburgh, Pa., who has been named chairman of the board for the new Association.

With a nation-wide membership of concerns whose primary purpose is supplying ball and roller bearings to the industrial trade for maintenance, the organization's first meeting was held last week at the Shamrock Hotel, Houston, Texas.

In addition to Mr. Chase, the following officers and directors were elected: J. R. Gelomb, Iowa Bearing Co., Davenport, Iowa, president; Gene Tappero, Michigan Bearing Co., Detroit, Mich., vice president; W. S. McClendon, Behrings Bearing Service, Inc., Houston, Tex., secretary; Harold E. Johnson, General Bearings Co., Chicago, Ill., treasurer.

INTERLAKE TO BOOST CAPACITY BY 23 PER CENT

▲ Interlake Iron Corp. has announced a $14,000,000 plant improvement and expansion program aimed at boosting its capacity for producing pig iron by 23 per cent.

The program calls for modernizing and enlarging its blast furnaces at Chicago, Ill., and Erie, Pa., and relining and improving a second blast furnace in Chicago. Upon completion of the program, Interlake's annual capacity will be expanded to 1,620,000 net tons of pig iron from the present 1,320,000 net tons.

With previous commitments of $20,400,000 for improving its blast furnace and coke oven priorities at Toledo, Chicago, Duluth and Erie, Interlake Iron's program of major improvements, begun in 1948, totals about $34 million. Of this about $12,500,000 has already been expended, leaving $21,500,000 for use between now and the end of 1953.

U. S. STEEL EXPANDS PRIVATE WIRE SERVICE

▲ United States Steel's nationwide private wire service has been fully converted to automatic controls which will speed up considerably the handling of the many thousands of telegrams which are transmitted each day between plants and offices of the organization, it was announced.

New push-button telegraph switching centers were officially placed in operation in Pittsburgh at 525 William Penn Place and in New York at 71 Broadway, replacing old cord-and-plug type telegraph centers in both cities. Other principal switching centers previously converted to automatic controls are located at Cleveland, Chicago, Birmingham, St. Louis, San Francisco and Los Angeles.

BRITISH STEEL WORKERS EARN $22.00 PER WEEK

▲ British steel employees last year received average weekly pay of slightly over $22.00, or approximately one-third as much as the average paid to employees in the steel industry of the United States, according to a comparison of statistics of the British Iron and Steel Federation and American Iron and Steel Institute.

In mid-1950, the basis of British data, the average for all steel employees in the United Kingdom was 7.91 pounds a week, equivalent at the current rate of exchange to $22.15. Employees of steel companies in the United States in the first seven months of 1950 averaged over $70.00 a week.

For that average payment, the British employees put in an average of over 46 hours a week. That was 7.5 hours more than the average in the United States, almost equal to one more American day a week.

NATIONAL ALLOY STEEL EXPANDS FOUNDRY

▲ National Alloy Steel Division of Blaw-Knox Co. is enlarging and rearranging its plant facilities to provide a 25 per cent increase in capacity.

Involved in the expansion project is an extension of the main foundry building, installation of additional moulding and centrifugal casting equipment, and improved shop layout to permit better flow of production.

Located at Blawnox, Pa., this division of the company specializes in the production of alloy and high alloy steel castings for service under unusual conditions of abrasion, corrosion, and high temperature. There is a pressing need for such products throughout industry and National Alloy Steel has a record backlog of orders on its books.

FORD IS BUILDING NEW SLAB HEATING FURNACE

▲ A new slab heating furnace will be constructed for Ford Motor Co.'s steel division at its Rouge plant, Dearborn, Mich., according to the designer-constructor, the Rust Furnace Co.

The new facility will supplement two furnaces now serving the plant's hot strip mill, increasing its rolled strip capacity, after furnace and mill revamping, to an estimated 300 tons per hour.

The new furnace will be zone-controlled, and triple-fired using either coke oven gas, natural gas, or fuel oil.

WOODWARD IRON ADDS NEW BOILER PLANT

▲ An engineering and construction contract for an addition to the boiler plant of the Woodward Iron Co., Woodward, Ala., was awarded to Rust Engineering Co.

The contract involves a new 125,000 lb per hr boiler together with auxiliaries including a 500,000 lb per hr feedwater heater and clarifier, with instruments, controls and piping.

The chimney, designed to serve both the new installation and a proposed boiler of similar capacity, will be constructed of radial brick.

The new boiler and its auxiliaries is designed for operation at 415 psig 600 F total temperature.

JAPANESE TO IMPORT PHILIPPINE IRON ORE

▲ The importation of iron ore to Japan has been approved by the Ministry of International Trade and Industry of the SCAP-sponsored Japanese government, the Philippine mission to Tokyo recently announced.

The ore will be procured from the Philippines, Hongkong, and sterling areas and covers the period from July 25 to September 29, 1951, it was noted.

In an additional announcement, the Bureau of Commerce stated that other commodities have been approved for importation by the Japanese government.

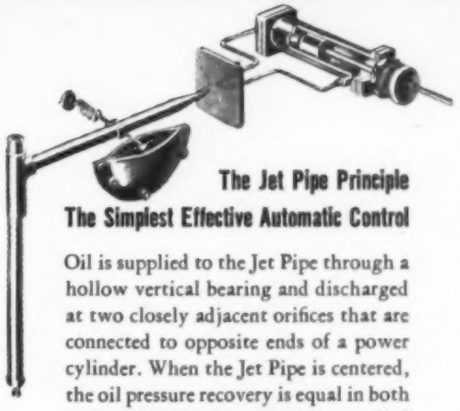
Nearly 100% Askania Controls
for Blast Furnace Blowers

Nearly every blast furnace blower installed in the United States since 1940 is Askania-controlled. This is quite a record, but it shouldn't surprise any steel man—it is based solidly on Askania's performance record.

Steel men like Askania's simplicity. The Jet Pipe principle makes this control system extremely simple and straightforward. It makes maintenance easy—and seldom needed. Control is responsive and dependable.

Steel men like Askania controls, too, because they are designed and built for continuous duty under severe conditions. They are self-lubricating, heavy-duty equipment—a highly-efficient application of controlled power for the Steel Industry. Steel men *know* and *trust* Askania controls.

Write for Bulletin 139. It tells about Askania controls for a variety of pressure, flow and proportioning applications.



The Jet Pipe Principle

The Simplest Effective Automatic Control

Oil is supplied to the Jet Pipe through a hollow vertical bearing and discharged at two closely adjacent orifices that are connected to opposite ends of a power cylinder. When the Jet Pipe is centered, the oil pressure recovery is equal in both orifices. But if a change in the controlled variable moves the jet pipe toward one orifice and away from the other, the recovered pressures become unequal, and the piston moves to operate the control valve or damper.

ASKANIA HY-PERFORMANCE Hydraulic Controls

ASKANIA REGULATOR COMPANY
240 E. Ontario St., Chicago 11, Ill.
A Subsidiary of General Precision Equipment Corporation

PROGRESS REPORT ON NATIONAL CARBON BLAST FURNACE LININGS

TRADE-MARK

33 BLAST FURNACES lined with "NATIONAL" carbon have now produced over 1 million tons. Of these, 12 furnaces have produced more than 1½ million tons and 4 have passed the 2 million ton mark.

These tonnages are for *original linings*. In every case, production has been characterized by remarkably trouble-free operation.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

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A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg

OTHER* NATIONAL CARBON *PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

C. H. Williams has been appointed assistant executive vice president--engineering and raw materials, United States Steel Co. Mr. Williams had been serving as chief engineer-manufacturing division. Mr. Williams is a past president of the Association of Iron and Steel Engineers.

A. J. Fisher, assistant chief engineer of construction for Bethlehem Steel Co., Bethlehem, Pa. since 1948, has been named general manager of the Johnstown, Pa., plant, succeeding Ralph E. Hough, retired. Mr. Fisher is a past president of the AISE.

Victor E. Schlossberg was appointed assistant general superintendent in charge of operating services at Indiana Harbor, Ind., works of Inland Steel Co. Other promotions saw **Arthur L. Schroeder** becoming assistant chief engineer, field, and **James M. Howard** being made assistant chief engineer, design. **Clarence L. Holmberg,** former assistant to the general superintendent, was transferred to the company's general offices in Chicago, Ill., as assistant general manager of sales.

Harry P. Saxer, former superintendent, blast furnaces, at Jones and Laughlin Steel Corp., Pittsburgh, Pa., has been named assistant works manager—general services of Pittsburgh works. **A. C. Keller,** formerly assistant general superintendent at Aliquippa, Pa., works has been named assistant works manager—production, Aliquippa works. **J. R. Powell,** former superintendent of the tin plate department at Aliquippa, is named assistant works manager—general services, Aliquippa works division. **J. H. Davis** at Pittsburgh, **R. A. Dye** at Aliquippa, and **P. W. Martin** at Otis in Cleveland, Ohio, have their titles changed to assistant to works manager—personnel relations, in their respective divisions. **J. R. Davey,** former assistant superintendent of the tin plate department at Aliquippa, is named superintendent of that department. **C. T. Snyder,** former general foreman—tin plate department, becomes assistant superintendent of tin plate department at Aliquippa. **R. W. Campbell,** former superintendent of the coke division, Pittsburgh district, is named staff specialist—coke and by-products on the staff of the vice president—operations. **J. R. Lowe,** former assistant superintendent of blast furnaces at Pittsburgh, is named superintendent of the blast furnace department, Pittsburgh works division. **C. D. Smith,** former technical assistant to blast furnace superintendent at Pittsburgh works, is named assistant superintendent of that department. **J. N. Imel,** former assistant superintendent of the strip-sheet department at Pittsburgh works division, becomes superintendent of that department. **J. A. Tischbein,** former assistant superintendent of rolling mills at Pittsburgh works division, is named assistant superintendent of the strip-sheet department at that works. **H. I. Smith,** former general foreman of centralized scarfing—blooming mills department, becomes assistant superintendent of the rolling mills department at Pittsburgh works division.

J. Donald Rollins has been appointed assistant vice president-engineering, United States Steel Co., Pittsburgh, Pa. Mr. Rollins has been serving as project manager of the company's Fairless works in Morrisville, Pa., supervising construction plans of the new U. S. Steel plant.

Robert A. Graney has been appointed to the newly created post of assistant general superintendent of Inland Steel Co.'s Indiana Harbor, Ind., works in charge of labor relations and training. Mr. Graney was formerly vice president in charge of industrial relations at Kaiser-Frazer Corp. and since December, 1950, has been an industrial relations consultant on the West Coast.

Howard U. Herrick has been elected president of E. W. Bliss Co., Canton, Ohio. Previously associated with Bliss as executive vice president from 1934 to 1944, Mr. Herrick's experience in top management positions in the press building industry dates back to 1924. Mr. Herrick's return to active management of Bliss was requested by the board of directors. Since his retirement in 1944 from active participation in the press industry, Mr. Herrick had resided in Fort Lauderdale, Fla. His offices are now located in the Bliss company's

C. H. WILLIAMS

A. J. FISHER

V. E. SCHLOSSBERG

J. DONALD ROLLINS

ESSENTIAL TO

Capacity Production

This new folder illustrates and describes Lintern Pulpit Aire-Rectifiers and their possible application to your requirements.

A majority of the pulpits, in the present expansion program, will be Lintern equipped. This expenditure to increase the efficiency of these skilled operators is a paying investment—essential to capacity production.

The line of Aire-Rectifiers is complete for all types of mill pulpits—for those of the most modern design to existing pulpits where costs must be kept down. Many parts are interchangeable with the crane cab Aire-Rectifiers, thereby keeping service parts stocks at a minimum. Sturdy and corrosive-resistant, especially designed and built to handle the heavy-duty, high temperature requirements of steel mill operation, these pulpit Aire-Rectifiers are not to be compared with ordinary commercial units. They have proven their merits in successful operation over the past four years. They do not require bulky, unsightly air ducts, nor valuable space within the pulpit.

Send today for folder. If you will tell us your conditions we can then write you fully.

THE LINTERN CORPORATION
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main plant at Canton, Ohio. The new president succeeds **Louis C. Edgar, Jr.,** who resigned November 12.

James L. Roemer, Jr., has been appointed assistant superintendent of tube mills at the Campbell, Ohio, works of Youngstown Sheet and Tube Co., succeeding M. G. Morgan who resigned recently. Mr. Roemer had been general foreman of butt weld tube mills.

C. D. Hazen was appointed superintendent of engineering and maintenance for Newport Steel Corp.,

C. D. HAZEN

Newport, Ky., in charge of all such activities in every branch of its operations. His previous connections were with Freyn Engineering division of Koppers Co., Inc., Youngstown Sheet & Tube Co., Wheeling Steel Corp., United Engineering and Foundry Co., and others. **H. W. Bradley** becomes general superintendent of the sheet mill section. He has had many years' experience in sheet mill operations at Armco and Inland.

H. W. BRADLEY

H. G. Hart, formerly of the Portsmouth, Ohio, sales district of Harbison-Walker Refractories Co., has been transferred to the new specialties and retail department in Pittsburgh, Pa.; **Floyd A. Pearce,** formerly of the Pittsburgh sales district, has been transferred to Portsmouth to replace Mr. Hart; and **E. A. Olson** has been appointed to the Pittsburgh sales district as a replacement for Mr. Pearce.

Robert L. Sommerville, assistant general sales manager of Electric Storage Battery Co., was elected president of the Association of American Battery Manufacturers recently at its annual convention in Chicago, Ill.

L. W. Reinken, chief engineer of W. Green Electric Co., Inc., was elected chairman of the Metallic Rectifier Section of NEMA (National Electrical Manufacturers Association) at a recent meeting in Cleveland, Ohio.

A. W. Plier has been elected executive vice president and general manager of D. J. Murray Manufacturing Co., Wausau, Wisc. **C. L. Durkee** was named vice president and sales manager.

Robin S. Kersh was elected executive vice president of Westinghouse International Co., New York, N. Y. He succeeds **E. V. Huggins,** who was recently named assistant secretary of the U. S. Air Force. For the past year, Mr. Kersh has been manager of the steam division of the Westinghouse Electric Corp. at South Philadelphia, Pa.

George H. (Jack) Woodard has been appointed manager of Republic Flow Meters Co.'s new company office at 2426 W. Holcombe Blvd., Houston, Tex. **Henry Weber** has been named district manager of Republic's new factory branch office at 1002 Second Ave., Seattle, Wash. **Charles Duffy** has been placed in charge of the Buffalo, N. Y., office with headquarters in the Prudential Building.

Charles T. Lewis has been appointed chief lubrication engineer for Republic Steel Corp., Cleveland, Ohio. In his new capacity, Mr. Lewis will also serve as chairman of Republic's lubrication committee.

John E. Didrickson was named middle west representative for Blaw-Knox Co.'s steel plant equipment department. With his headquarters at the company's

JOHN E. DIDRICKSON

Chicago, Ill., office, Mr. Didrickson will serve the steel industry in connection with Blaw-Knox water-cooled equipment and furnace accessories.

William E. Schnitgen has been appointed lubrica-

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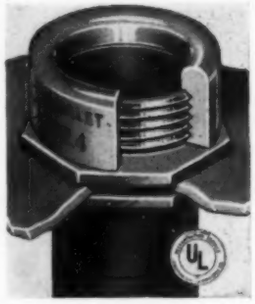
of "Sali" Insulating Bushings



plus

- undercut shoulder for trim fit to conduit.
- compactness, requiring less room.
- shoulders fully supported by conduit.

plus

Easy to install.
Truncated threads are made to NEMA standards.
All-insulating * "Sali" material.
Precision gages control production.
Cost no more than old-style bushings.

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Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

tion engineer of the Warren, Ohio, district of Republic Steel Corp.

Harry S. Jones has been promoted to the position of divisional superintendent of tube mills in the Youngstown, Ohio, district of Republic Steel Corp. **James McClintock** has been made superintendent of the continuous weld tube mills, succeeding Mr. Jones. **Edward Weden, Jr.,** has been made assistant superintendent of the continuous weld tube mills, succeeding Mr. McClintock.

G. B. Davis has been elected vice president in charge of sales for Baker-Raulang Co. Mr. Davis, a veteran of 17 years with the company, replaces **John R. Morrill** who recently resigned.

John N. Kerr has been made vice president of Grafo Colloids Corp. His headquarters will be at 310 Wilkes Place, Sharon, Pa. Mr. Kerr was formerly Pittsburgh, Pa., district manager for the Sun Oil Co.

Raymond L. Carey has been appointed assistant chief engineer of Taylor-Wilson Manufacturing Co., Pittsburgh, Pa. Mr. Carey was formerly with Jones and Laughlin Steel Corp. at Aliquippa, Pa.

Howard J. Stagg has been appointed director of training for Crucible Steel Co. of America. Mr. Stagg, who for the time being will make his headquarters in Syracuse, N. Y., will be responsible for the organization, planning and direction of training programs in all Crucible departments at all levels.

Roger W. Berrett has been appointed to the post of purchasing agent for American Steel & Wire Co., Cleveland, Ohio, succeeding **Frank E. Chesney,** who has retired. Mr. Barrett had been senior purchasing agent since April 1951.

A. E. Cichelli has been named lubrication engineer

A. E. CICHELLI

of the construction and engineering division of the Bethlehem Steel Co., Bethlehem, Pa. **J. A. Gleber** succeeds Mr. Cichelli as lubrication engineer at the Sparrows Point, Md., plant.

ANOTHER FALCON CONTRIBUTION

TO OPERATING EFFICIENCY

If air could conduct heat better than water, you would circulate air through your copper cooling plates. But you are aware of what trapped air does to a tuyere or to a bosh plate. It has been a major threat to operating efficiency . . . and Falcon non-ferrous casting specialists have come up with the answer. Falcon has created an AIR-FREE COOLING PLATE and an AIR-FREE TUYERE.

It is another of the many examples of Falcon pioneering . . . constantly affording you the current best in copper castings, through specialization . . . and contributing immeasurably to longer equipment life and maximum reduction of down-time.

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Clarence B. Randall, president of Inland Steel Co., Chicago, Ill., was designated the chief executive officer of the company by the board of directors recently. The board acted at the request of **Edward L. Ryerson,** chairman, whose office has previously carried top executive responsibility. Mr. Ryerson, who would be due to retire January 1 under the company policy of retirement of executives at 65 years of age, will continue as chairman but in a "consultive and advisory" capacity. **Joseph L. Block** was elected executive vice president and chairman of the finance committee. He has been vice chairman and vice president in charge of sales. **John F. Smith, Jr.,** who has been general manager of sales, was elected vice president in charge of sales. **L. E. Block,** one of the founders of the company who served as chairman of the board from 1919 to 1940 and chairman of the finance committee since that time, was elected honorary chairman of the board.

Don S. Smith, general production manager of Wellman Bronze & Aluminum Co., Cleveland, Ohio, for the past year, has been appointed vice president in charge of production.

Thomas B. Hogan was named general superintendent of the McKees Rocks, Pa., chain manufacturing plant of McKay Co. Mr. Hogan has been with the company since 1935.

James R. Thompson, manager of the metallurgical department at American Steel & Wire Co., Cleveland, Ohio, has retired after 50 years service.

J. C. Hydrick was named works manager of the Delta-Star Electric division of H. K. Porter Co., Inc., Chicago, Ill. Previous to his present position Mr. Hydrick was most recently chief engineer of Quaker Rubber Corp., another Porter subsidiary.

E. J. Morgan is now associated with the industrial division of the Chicago, Ill., office of the J. A. Zurn Mfg. Co., Erie, Pa. Mr. Morgan has had more than 40 years of varied experience as a mechanical engineer, 30 years of which he was associated with De Laval.

Russell S. Roeller was appointed general sales manager for Pennsylvania Salt Manufacturing Co., Philadelphia, Pa. Mr. Roeller previously was an assistant general sales manager, a position now eliminated. **Albert H. Clem** was named field sales manager and **Edwin S. Garverich** became manager of technical service.

C. S. Chapman has been made central district manager of National Carbon division of Union Carbide and Carbon Corp., with headquarters at 230 N. Michigan Ave., Chicago, Ill. Mr. Chapman had been southwestern manager in Atlanta, Ga.

Frank E. Chesney, purchasing agent and a director of the American Steel & Wire Co., Cleveland, Ohio, retired November 30, after nearly forty years of service with the company.

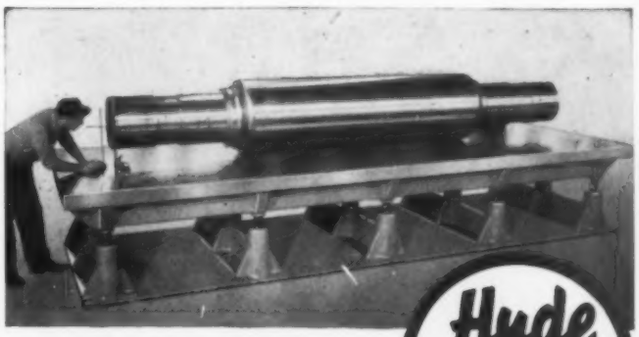
William R. Miller was named to the post of manager of the metallurgical department of the American Steel & Wire Co., Cleveland, Ohio. Mr. Miller had been assistant manager of the company's metallurgical department.

Joseph H. Humberstone, has been elected a vice president of Air Reduction Co., Inc. He was formerly the president of the company's Airco Equipment Manufacturing division and he has been succeeded in that capacity by **Scott D. Baumer.**

James H. W. Conklin, has been appointed general

JAMES H. W. CONKLIN

sales manager of the Philadelphia Division, Yale & Towne Manufacturing Co. Mr. Conklin succeeds **James P. Kinney** who is taking over Yale & Towne's distributorship in Los Angeles and Southern California.



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INQUIRIES INVITED

HYDE PARK FOUNDRY & MACHINE CO.

HYDE PARK, PA. (PITTSBURGH DISTRICT)

Ernest D. LeMay retired January 1, 1952, after 40 years service with Tennessee Coal, Iron and Railroad Co., Birmingham, Ala., 15 years of it as public relations director. **John L. Mortimer,** director of public relations for United States Steel in the Gulf-Southwest district, succeeds Mr. LeMay as Southeast district public relations director, with headquarters in Birmingham. **Stephen T. McGinnis,** assistant director of public relations with the Tennessee Company, which on January 1 became the Tennessee Coal & Iron Division of United States Steel Co., has been promoted to the position of associate director of the Southeast district and **R. Clay Bailey,** presently field representative in the Gulf-Southwest district, which will continue under the supervision of Mr. Mortimer, has been appointed associate director of that district.

Fred W. Arndt was appointed direct representative to cover the eastern states for Heil Process Equipment Corp. His headquarters are at 152 West 42nd Street, New York, N. Y.

John L. Fuller has been appointed to the newly created administrative post of manager of research and

JOHN L. FULLER

technical services for Reliance Electric and Engineering Co., Cleveland, Ohio. Since September, 1950, Mr. Fuller has occupied the position of technical co-ordinator in Reliance's engineering department.

Dr. Lauriston C. Marshall has been appointed director of Link-Belt Co.'s new physical testing and research laboratory at Indianapolis, Ind. As director of the new laboratory, Dr. Marshall will be responsible for an extensive program of original research, as well as for continuing investigation into ways and means of improving production methods and the quality of conveyor and power transmission products developed by Link-Belt's 16 manufacturing plants in the United States, Canada and South Africa. Dr. Marshall has been professor of electrical engineering at the University of California, Berkeley, Calif. He is currently head of the Microwave Laboratory operated at Berkeley under the joint sponsorship of the U. S. Air Forces and the Research Corp.

J. C. Willey has been appointed assistant to the president of Harbison-Walker Refractories Co., Pittsburgh, Pa. The son of former Harbison-Walker president, Raymond Willey, he has worked with the company in a variety of operating and executive positions since 1934.

Obituaries

Earl L. Windenburg, 59, sales engineer, Cutler-Hammer, Inc., in Cleveland, Ohio, died of a heart attack on December 15.

Phil S. Harvey, vice president, C & D Batteries, Inc., Conshohocken, Pa., died October 27.

James M. Brown, 50, manager of the Cleveland district industrial sales office of Surface Combustion Corp., passed away on December 3. Mr. Brown was born in Pittsburgh and was a graduate of Carnegie Tech. He had been associated with Surface Combustion Corp. since 1927.

Charles G. Thornburgh, 62, vice president of Rust Engineering Co., Pittsburgh, Pa., died December 5.

Edward B. Gray, 64, Pittsburgh, Pa., district representative for John Waldron Corp., died December 4.

James R. Armitage, electrical turn foreman, Wheeling Steel Corp., Steubenville, Ohio, died recently.

Kenneth H. Quail died November 6, 1951. He had been an employee of Detroit Edison Co. for nearly 30 years.

William L. Scott, 65, assistant general superintendent of National Tube Co.'s National works in McKeesport, Pa., died December 3.

F. B. Osterman, chief proposal engineer for Continental Foundry and Machine Co. for the past four years, died December 13. Mr. Osterman was formerly chief draftsman of United Engineering and Foundry Co. for fifteen years. He also had worked at Jones & Laughlin and Mesta Machine Co.

William A. Irvin, 78, who was president of the United States Steel Corporation from 1932 until January 1, 1938, died January 1. The U. S. Steel Co. Irvin works at Dravosburg, Pa., was named in honor of Mr. Irvin.

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JANUARY 2 - 31

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... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Composite Instrument Catalog

A catalog is available which describes the principal instruments, control devices and related components manufactured by the Industrial Division of Minneapolis-Honeywell Regulator Co. Specifications of approximately 100 measuring and control instruments, and valves are outlined. Included are several new designs including the differential controller and "Tel-O-Set" controller family. (5000).

(2) Flue Gas Analyzer

An instrumentation data sheet describes the Davis indicating and recording flue gas analyzer which utilizes a Davis thermal conductivity gas analyzer in combination with a Brown "ElectroniK" recorder. The combined apparatus provides continuous recorded combustion analysis. The data sheet describes the equipment and explains how it is used for combustion control analysis and describes the operation and construction of the apparatus. Photographic illustrations and schematic diagrams facilitate the explanation of the device and are included in the four-page data sheet. (10.15-3a). Industrial Division, Minneapolis-Honeywell Regulator Co.

(3) CO_2 Recorder

Availability of a new CO_2 recorder designed to meet the high standards of speed and accuracy of large industrial power plants and central stations is announced in a new catalog. The instrument utilizes three established ideas: 1. The use of CO_2 measurement as a guide to combustion efficiency. 2. The thermal conductivity principle of gas analysis. 3. Electronic type operation. Included is a detailed explanation of the operation of the analyzing and recording sections; a completely illustrated discussion of component parts and features; drawings of and information on gas sampling system. (51-1008). Hays Corp.

(4) Limit Switches

Three new bulletins covering rotating-type, lever-type, and track-type limit switches have been announced as available. Each publication contains descriptive and application information, switch ratings, and a number of photographs and dimension drawings. The rotating-type limit switch, for application where reversing operation is to be co-ordinated with the number of revolutions of a motor shaft or driven equipment, is covered in bulletin GEA-5704. Bulletin GEA-5705 describes the lever-type limit switch for use where it is desired to make or break a control circuit at a certain point in the travel of a machine part or mechanism. The third publication, GEA-5707, deals with the track-type limit switch, which is offered with four interchangeable operating heads. General Electric Co.

(5) Nickel Alloy Steel Castings

A 32-page bulletin on nickel alloy steel castings is available. Reports on steel, cast to shape, as a reliable engineering material are included. Low temperature properties, abrasion resistance, depth hardening and welding are discussed. Advantages and recommended specifications and compositions for typical service applications are given. International Nickel Co., Inc.

(6) Lubricated Plug Valve

A new fully-descriptive catalog covering the entire line of Porter lubricated plug valves is now available. By means of cross-section and cut-a-way illustrations as well as line drawings the unusual features of this modern design valve are presented. The valve is particularly adapted for use where positive, leak-proof operation as well as corrosion resistance is demanded. The oil, gas, chemical and process industries use vast numbers of lubricated plug valves. Sizes of the valve range from ½ in. to 12 in. Larger valves are manufactured on order. Information on working pressures, materials of construction, design and function, manufacturing methods, accessories, lubricants, and pressure and temperature ratings is also included. Porter Valve Division, H. K. Porter Co., Inc.

(7) Steel Handling

Handling and storing bar and rod stock was made a great deal simpler at the Jones & Laughlin warehouse in Detroit, Mich., when a J & L employee designed a clever sectional rack for storing the steel, and a crane truck took over the handling job. Before it had the racks and crane truck, the warehouse kept up to ten men busy storing steel and filling orders. Expensive overtime was piling up. Now one truck operator and two helpers do the whole job. Baker Case Study 3051, available to you, uses action photos to show how Jones & Laughlin put new zip in its steel handling system. It is one in a series of materials handling case studies being offered. Baker Industrial Truck Division of The Baker-Raulang Co.

(8) Furnace Maintenance

A new manual entitled "Maintenance Guide for Electric Heat Treating Furnaces" is available. This manual was written to guide management and operators in the maintenance and use of electric heat treating furnaces. A handy check sheet is included in the manual to simplify maintenance schedules, reduce breakdowns and prolong furnace life. Hevi-Duty Electric Co.

(9) Truck Handling Fixtures

The efficiency and utility of the power industrial truck can be greatly increased through the use of special load handling fixtures. To aid in selecting and applying devices of this nature, publication of a new brochure illustrating and describing more than 25 special

attachments is announced. Included are such devices as revolving forks, roll paper clamp, hook and boom, electro-magnet, ladle, pourer, remote control, upender and many others. Elwell-Parker Electric Co.

(10) Platform Trucks

Descriptive literature on a recently announced "Porter" all-purpose platform truck has been published. The 2000-lb capacity unit is designed for use in freight stations and highway truck terminals as well as factories, warehouses and shipping centers. It is manufactured in two over-all lengths, 91 in. and 109 in. Automatic Transportation Co.

(11) Heat Treat Review

If you are not already acquainted with the "Heat Treat Review," published periodically by Surface Combustion Corp., here is your opportunity to receive a copy. This comprehensive well-illustrated magazine should be of interest to all persons concerned with heat treating processes. Each issue contains reliable information on the latest processes and the most advanced fuel-fired equipment. The fourth issue, Vol. 2 — No. 2, which is now available, features such timely articles as "Batch Furnaces for Continuous Production" and "Protective Atmospheres for Annealing Non-Ferrous Wire." Surface Combustion Corp.

(12) Industrial Lighting

Available to you are the first five of a series of "See Better — Work Better" publications being published by General Electric's Lamp Division to further the cause of more effective industrial lighting. General Electric Co.

(13) Heat Processing

Processing is defined broadly as "a series of precise preparations to achieve either a better product, more production, lower unit costs —most often a combination of all three," in a new bulletin, "Why Heat Processing," just issued. The bulletin emphasizes the increasing need for precision in heat processing that is comparable with the precision in chemical compounding, metal machining, glass forming, paper making and textile production. Principles of heat application to a wide variety of solid and fluid products are illustrated and described in the bulletin. (S-7.2). Selas Corp. of America.

(14) Plant Construction and Engineering

The engineering services offered by York Engineering & Construction Co. of Pittsburgh, Pa., are described in a 4-page folder just published. These services include the design of buildings, foundations, and equipment for industrial plants, as well as project coordination and control.

(15) Drawing Compounds

The physical properties and applications of drawing compounds for every type of drawing operation are included in a revised edition of "Drawing Compounds by Houghton," an informative 4-page folder recently released. For easy reference the folder is divided into sections on compounds for general purpose, non-ferrous, magnesium, aluminum and steel drawing. Pigmented, synthetic, polar and dry film types of drawing compounds are also described. E. F. Houghton & Co.

(16) Fuel Oil Heaters

A new catalog is available explaining the advantages of our oil tank suction heaters for heating heavy grades of fuel oil to pumping temperatures, and also on our preheaters which raise the oil from pumping temperature to the higher temperature required at the burners for good atomization, combustion and control. (714). Hauck Manufacturing Co.

(17) Plugs and Receptacles

Just issued is a new four-page bulletin describing a complete line of exceptionally versatile "Triploc" industrial plugs and receptacles for high cycle tools, and other portable electrical equipment; also for use with detachable power, lighting, remote control, instrumentation, communication, sound and inter-vehicular circuits. Exclusive safety features and the reversible and interchangeable contact units are fully described and illustrated. Sizes and styles from 1 to 8 poles with ratings from 0.2 amps 600 volts d-c to 60 amps 250 volts a-c are tabulated for easy reference and specification. Typical circuit diagrams are included. (603). Pyle-National Co.

(18) Water Alarm

A new "Hi-Lo" water alarm, based on the same established thermostatic principle as the Copes Feed Water Regulator, has been announced in a new folder. Designed primarily for high-pressure service, it is dependable at all working steam pressures on both stationary and marine boilers. It uses no bellows, no diaphragms, no weights, no floats, no differential pressure devices. It has no internal parts to wear or corrode. Standard audible signal is a horn; standard visible signal, lights. The alarm is easily installed without special supports or complicated piping, with or without a water column. (493). Northern Equipment division of Continental Foundry and Machine Co.

(19) Centrifugal Blowers

Construction features of Allis-Chalmers multi-stage Type V centrifugal blowers for equivalent air pressures above 6.5 psig and inlet volumes above 1500 cfm are described in a new bulletin just released. Illustrations include a complete cross-section of a multi-stage Type V gas exhauster, photographs of components of multi-stage Type V blowers, of two-stage, three-stage and four-stage blowers with the tops of their casings removed, and of typical installations in a variety of industries. (19B6104A). Allis-Chalmers Manufacturing Co.

(20) Materials Handling Analysis Guide

Much of the mystery of analyzing materials handling problems can be removed by answering just 28 simple questions. To back up that statement, the "Materials Handling Analysis Guide" has just been published, by the Automatic Transportation Co. The 16-page pocket-size booklet was prepared to assist the thousands of factories and warehouses where no full-time materials handling engineer is on the staff. The guide affords a method of determining rapidly basic materials handling requirements of a business. Subjects the questions deal with include the relationship of materials handling to production, costs, shipping, and packing.

Included is a simple "scorekeeping" system that determines if a firm needs further help in investigating ways to eliminate its problems.

(21) Carbon Brushes

A new booklet is available describing carbon brushes for electrical machines. Discussed are the types of brushes available; definition of brush characteristics; fractional horsepower brushes; industrial brushes; characteristics, description and use; shunt descriptions; springs; split brushes; contacts; hammer and lifting clips; and terminals. The book is extremely well-illustrated and includes numerous cutaway diagrams. Included are suggestions for eliminating brush troubles. Every steel mill electrical maintenance supervisor should have this book in his file. U. S. Graphite Co.

(22) Pyrometer Supplies

A new catalog just published furnishes much useful technical data on the application and use of thermocouple pyrometric supplies. Catalog includes a complete line together with basic prices of all Brown standard thermocouple assemblies including base metal elements and Noble metal elements of all gages. The information is given as to the ordering procedure for various complete assemblies as well as the extension wire, terminal heads and blocks, primary and secondary protecting tubes, insulated charts, ink, insulated thermocouple wire and other pertinent information. Exploded view of all assemblies plus special molten metal, pencil type and midget thermocouples are included. (100-4) Industrial Division, Minneapolis-Honeywell Regulator Co.

(23) Rod Selection Guide

A rod selection guide for "Amscoating" with Amsco hardfacing products has just been released. This chart breaks down into basic operations, the parts that can and should be hardfaced for longer life. The fields are materials working, crushing and pulverizing, materials handling, and power transmission. The rod selection guide gives the name of the part, the recommended rod, sizes, and method of application. (SG) American Manganese Steel Division of American Brake Shoe Co.

(24) Silent Check Valves

Silent check valves, designed to prevent water hammer, are described and illustrated in a 4-page bulletin just issued. These valves not only eliminate the noises, but also prevent the pressure surges which can result in damage to pipes, valves, liquids and other parts of piping systems. Built in all regular pipe line sizes from one through twenty inches, these valves are capable of handling all liquids hot or cold, such as water, oil, gasoline, acids, chemicals, gas, air, salt water, brine, etc. Manufactured from a variety of materials as the service requires, they can be installed in any position. The bulletin includes technical data, cut-away versions of two types of valves and a series of installation photographs. (WH-100) Williams Gage Co.

(25) Dust Collectors

Just published is a new 36-page catalog, "Dust and Fume Control" which describes the various sizes and models of "Dustube" collectors (cloth-tube type) and the advantages to be gained from cloth filtration. Standard assembled and knocked-down models of this equipment have a range of air flow capacities upward from 252 cfm and filter the air through various kinds of cloth — cotton, wool, and synthetics — depending upon the application. Continuous automatic collectors are provided where requirements are such that service must not be interrupted for shaking the filters to release accumulated dust. The description of each type of collector is accompanied by complete specifications, construction drawings, cut-away views, and illustrations of typical installations. (72-B). American Wheelabrator & Equipment Corp.

(26) Motorized Hand Trucks

A new 16-page bulletin describing the application, types and operation features of the Yale line of motorized hand trucks and electric stackers has been released. Known as the "Worksaver" line, these "ride-'em or walk-'em" industrial trucks are available in capacities up to 6000 lb and are designed for applications where high maneuverability is desired. They are particularly suitable for areas where floor capacities preclude the use of sit-down type trucks, but where the cost-saving advantages of mechanized handling are desired. A special section shows the various attachments available for the Worksavers that permit handling of a wide range of objects without pallets. (P809). Yale and Towne Manufacturing Co.

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ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ALDRICH PUMP CO.	DATA SHEET 61-2	Gives data on Aldrich spray nozzles.
51	AMERICAN CHEMICAL PAINT CO.		Descriptive folder available on "Rodine."
52	AMERICAN MANGANESE STEEL DIV., AMERICAN BRAKE SHOE CO.		Catalog available on dollar-saving Amsco electrodes.
53	ASKANIA REGULATOR CO.	BULLETIN 139	Tells about Askania controls for pressure, flow and proportioning applications.
54	BAILEY METER CO.	BULLETIN 15-D	Describes Bailey boiler control.
55	BLISS CO., E. W.		52-page brochure available on Bliss mills.
56	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Describes Browning mill type cranes.
57	DREVER CO.	BULLETIN B-52	Gives all the facts about dissociated ammonia, pure dry hydrogen and nitrogen.
58	ELECTRIC PRODUCTS CO.	BULLETIN 2-200	Gives information on custom-engineered a-c and d-c motors and generators.
59	ELECTRIC SERVICE MFG. CO.		Catalog available giving details on the complete line of Keystone insulators.
60	ELLIOTT CO.		Bulletin available on Elliott d-c motors.
61	FARVAL CORP.	BULLETIN 25	Gives figures on savings possible with Farval on the types of machines you operate.
62	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETINS LPB, GMA and HGB	Describe straight line drives, gear-motors and gear drives.
63	FOXBORO CO.	BULLETIN 420	Tells about the Foxboro differential pressure cell.
64	GENERAL ELECTRIC CO.	BULLETIN GEA-5408	Contains information on G-E crane drives.
65	HOMESTEAD VALVE MFG. CO.	CATALOG 39-5	Gives complete information, sizes and prices of Homestead-Reiser "Self-Seald" lubricated plug valves.
66	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Fast's catalog gives detailed descriptions, engineering drawings, capacity tables and photographs.
67	LESLIE CO.	BULLETIN 513	Describes Leslie double seated diaphragm valves.
68	LINTERN CORP.		Folder illustrates and describes Lintern pulpit "Aire-rectifiers."
69	LOVEJOY FLEXIBLE COUPLING CO.		Complete catalog and handy, quick-finding selector charts available on flexible couplings.
70	MARVEL ENGINEERING CO.	FOLDER 105	Gives complete data on synclinal filters.
71	MEDART CO.		Complete catalog available on Medart 2-roll rotary straightener, sizer and polisher.
72	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION		84-page bulletin available entitled "Instruments Accelerate Research."
73	OAKITE PRODUCTS, INC.		24-page illustrated bulletin available on Oakite solvent detergents.
74	PACIFIC PUMPS, INC.	BULLETINS 106 AND 109	Gives full details on Pacific pumps.
75	POOLE FOUNDRY AND MACHINE CO.		Catalog obtainable on flexible couplings.
76	POST-GLOVER ELECTRIC CO.		Bulletin 500 gives complete data on nonbreakable steel grid resistors.
77	TAYLOR CHAIN CO., S. G.		Booklet available containing all the facts and specifications on TM alloy steel chain and attachments.
78	TIDE WATER ASSOCIATED OIL CO.		Bulletin available on "Tide Water Associated Lubricania."
79	UNITED STATES GRAPHITE CO.		40-page catalog gives complete information on standard USG grades.
80	WAGNER ELECTRIC CORP.	BULLETIN MU-132	Gives full details on Wagner corrosion-resistant motors.
81	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4016	Gives complete information on Westinghouse metal-clad switchgear.

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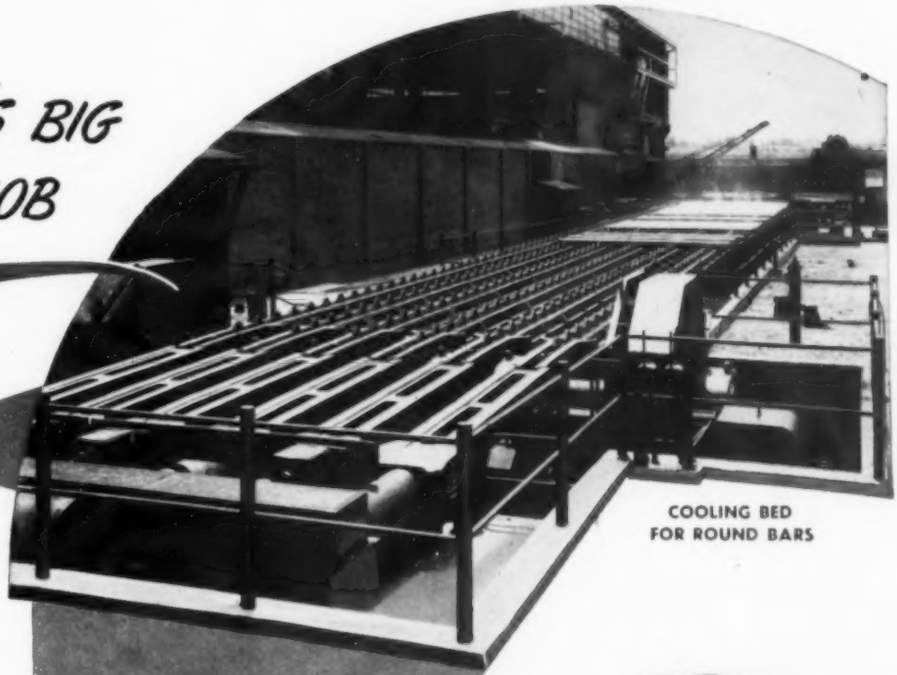

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FOR ROUND BARS

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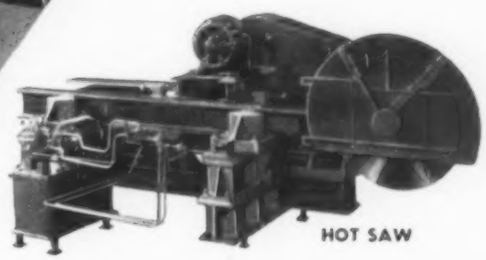
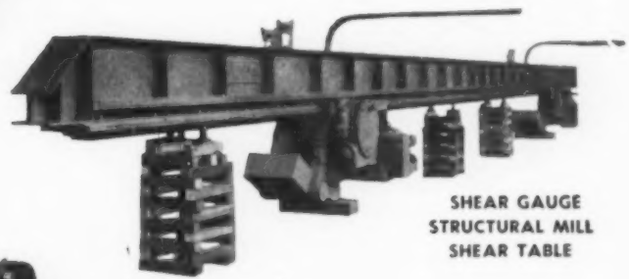
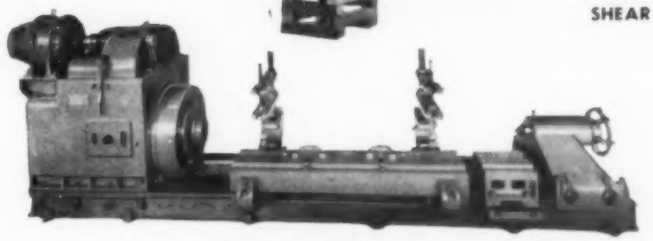


HOT SAW



SHEAR GAUGE
STRUCTURAL MILL
SHEAR TABLE



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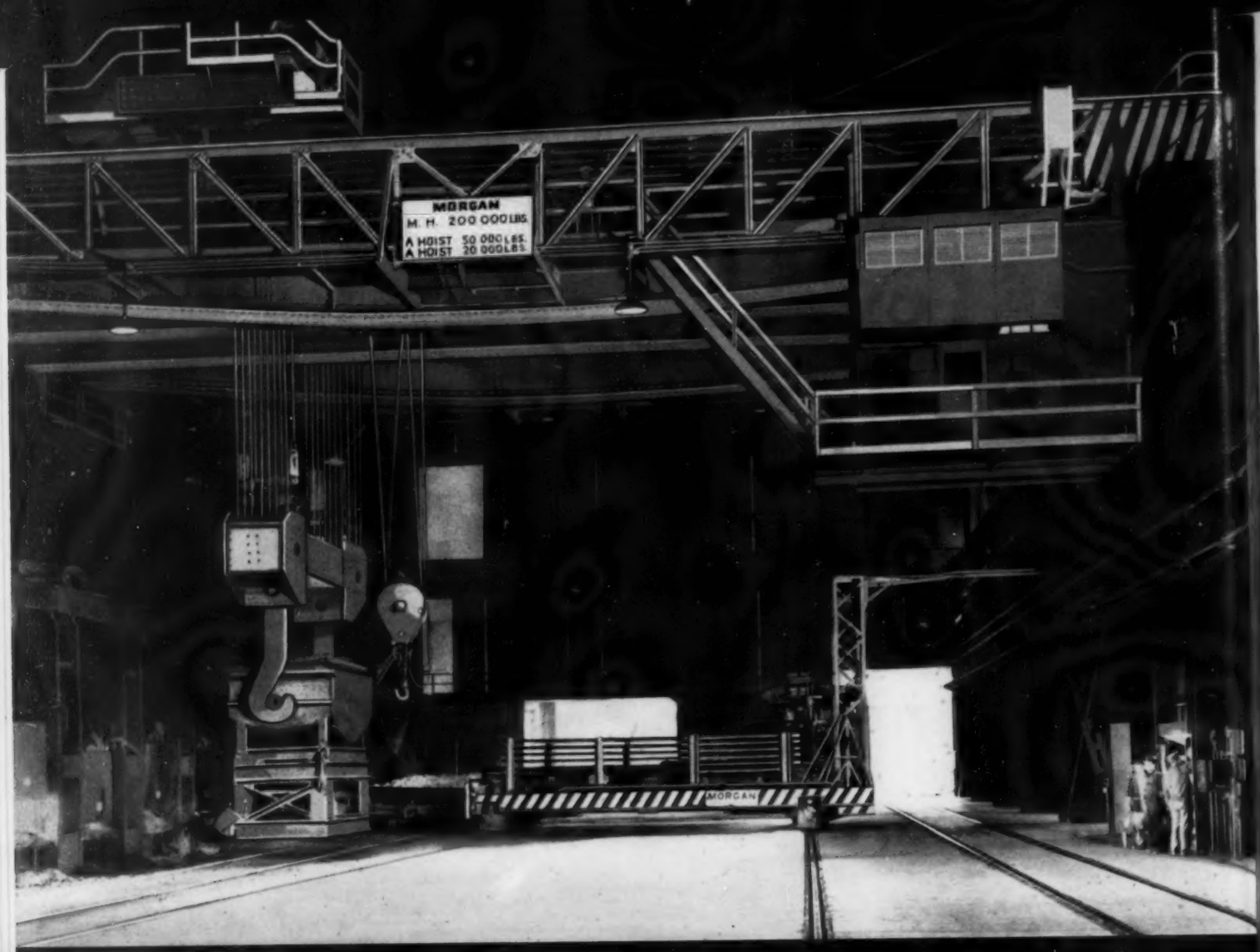
The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio



Illustrated is a 100-ton, 80'-0" span, 4-girder type Ladle Crane and a 7½-ton, 26'-0" span Floor Charger.

BUILT BY MORGAN Engineering

Morgan equipment is built to last a long time as Morgan engineers rely upon a highly skilled shop organization, modern equipment, and progressive ideas in building Morgan steel mill machinery.

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Equipment News...

METAL-CLAD SWITCHGEAR

▲ A new standard line of metal-clad switchgear, ranging in ratings from 2400 to 13,800 volts, 150 to 500 mva, has been announced by the General Electric Co. The new line offers many new and improved design features, although it retains the same general arrangement of major components.

One of the most important aspects of the new equipment line is that in introducing the new design improvements all industry standards have been retained.

The new line offers completely pre-engineered units for the most commonly encountered kinds of power apparatus and circuits.

G-E design engineers point out several significant features of the new equipment. One of these new design improvements is in the magne-blast circuit breaker, in which a maximum number of parts are interchangeable among breakers of different ratings. For example, solenoid mechanisms and many contact and arc extinguisher parts are identical in all ratings.

Another feature is an electro-mechanical control device, built integral with the breaker mechanism. It is the heart of a control circuit system which is identical for all breakers operated from the same control voltage. Auxiliary switches for non-control functions are mounted on the stationary structure of the gear.

A new and improved insulating material having excellent flame-retardant, dielectric and anti-hygroscopic properties is used throughout the breaker. Its use serves to localize damage which may occur if abnormal conditions—such as lightning surges from inadequately protected lines, subjection to short-circuit duty in excess of rating, or mechanical damage from external causes—produce breakdowns.

The equipment framework is of completely welded construction. It is specifically designed to withstand rough treatment during shipment and installation.

Another design improvement simplifies the breaker elevating mechanism which has a new positive-acting mechanical interlock and provides faster raising and lowering of the breaker. All elevating mechanisms are driven by a motor, which is demountable for hand crank operation, and is controlled by a safety interlocked control system. Downward movement of the breaker from vibration is prevented by an anti-creep device.

The new equipment line has recessed screened vertical openings which provide top ventilation and at the same time prevent the entry of falling dirt and casual drip.

Cable entrance facilities are interchangeable from top to bottom entry. Direction of entry need not be determined prior to delivery to the user.

PALM OIL SUBSTITUTE

▲ U. S. tin plate producers are no longer dependent on imported palm oil for the essential lubricant in rolling operations. Research by the Ironsides Co. of Columbus, Ohio, has perfected a superior lubricant produced entirely from freely available domestic materials. The new lubricant duplicates all the chemical characteristics of palm oil. It looks, feels, acts, handles like palm oil and requires no changes in rolling mill operation. It is superior to palm oil in that it is subject to exact chemical control.

Trade-named "Palmoshield," the new Ironsides lubricant has been under continuous testing for the past three years in cold rolling steel production under standard operating conditions. Rolling characteristics were equal to palm oil. The cleaning operation was above average. Annealing and temper rolling were up to standard in every way. Tinning, both hot dip and electrolytic, yielded a most satisfactory product. During this testing "Palmoshield" was reclaimed with good results bo'h as to yield and product.

All tests have substantiated the fact that domestic "Palmoshield" has four distinct advantages over imported palm oil: 1. "Palmoshield" is widely available in this country. Users are not dependent on shipping during unsettled world conditions. 2. The domestic materials which go into the lubricant are so freely available as to supply all steel production of the United States without "borrowing" from other defense requirements. 3. Due to its availability, the new lubricant need not be stockpiled. However, there is no deterioration from extended storage. 4. The lubricant is subject to exact chemical control. The free fatty acid content does not vary from batch to batch and can be specified by the user.

A number of steel mill laboratories have checked all the chemical characteristics of the lubricant as being well within the data limits for palm oil. One mill operator, in fact, has still to be convinced that palm oil is not an ingredient of "Palmoshield."

With production now on a commercial basis, it would appear that users of palm oil in rolling mill practice, whether for tin plate, sheets or strips, either steel or alloys, will no longer have to wait for their "ship to come in."

D-C CONTACTORS

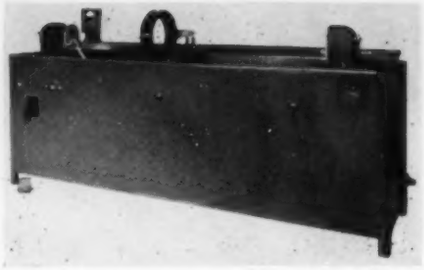
▲ New d-c contactors for steel mill and other heavy-duty industrial applications are available from Westinghouse Electric Corp.

These contactors, known as type M, are accessible from the front. Their alignment is independent of the accuracy of panel drilling, with only three mounting holes required. Contacts and shunts can be replaced easily without the removal of any other parts. Operating coils are removed by taking out three bolts. This unit construction reduces maintenance resulting from misalignment of separately-mounted contactor parts.

These contactors feature self-cleaning, knife-edge bearings that are not affected by dust. The design also incorporates a new-type arc box to provide faster arc interruption, and

to maintain correct alignment with the moving armature.

Electrical interlocks are mounted directly on the contactor frame and maintain correct alignment with the moving armature. No operating linkages are required. These contactors are available in all NEMA ratings from 25 to 2500 amperes.



MAGNETIC INSPECTION

▲ A complete re-engineering by Magnaflux Corp. is announced, creating a full new line of equipment for magnetic particle inspection. This has greatly improved delivery time and in many instances, reduced costs to meet the expanding needs for nondestructive testing created by the needs of the national defense program. This was done while "special" inspection equipment requirements were making excessive demands upon the company's engineering facilities during 1951.

A number of detail improvements were made on the new line of standard units. In most cases the new units are larger than the old units at comparable price—from 48 in. old to 54 in. new capacity, and from 72 in. old to 96 in. new. The new units can handle a greater diversity of parts for inspection. They are now built for either 220 or 440 volts, 60 cycle, interchangeably. Maintenance, though a relatively minor item, has been reduced and/or simplified.

Several factors combined to dictate the need for this "overhauling" of the standard unit lines. Being a comparatively young organization, (21 years), many of the standard units were designed and refined over the years to fill a specific need, and then "hung on" to become standard. Thus, the entire line was not well scaled from the standpoint of price and utility. As the volume of incoming orders increased, delivery times began to slow down because excessive work load was being put on every division of the company. The fundamental axiom that large numbers of a few different units can be handled more easily than a few numbers of many different units was the key to the entire program.

Benefits of the re-engineering program for manufacture in higher volume with quicker delivery have been: reduced departmental burden; greater productivity; smaller stocks of components; increased volume; and simplification of service procedures.

CO_2 RECORDER

▲ Hays Corp. has announced the availability of a new CO_2 recorder designed to meet the high standards of speed and accuracy of large industrial power plants and central stations. The instrument utilizes three established ideas: 1. The use of CO_2 measurement as a guide to combustion efficiency. This principle (that each gas has a distinct ability to conduct heat) has been used in thousands of boiler plants and industrial furnaces, particularly where a single fuel such as natural gas, oil, bituminous or anthracite coal is burned. 2. The thermal conductivity principle of gas

In all your
PICKLING OPERATIONS

LET THE NEW
WELDCO
MECHANICAL PICKLER

Are you pickling bars, tubing, rounds, flats, squares, or hexagons? Then it will pay you to check these 7 big advantages of the new WELDCO Pickler:

1. Saves 40 to 60% pickling time.
2. Saves on man power, steam, and maintenance work.
3. Uses a minimum amount of chain—often an expensive replacement item.
4. Mechanical operation provides a more vigorous pickling action, exposing all surfaces to the solution and speeding scale removal.
5. Can be built to any capacity.
6. Can be made to fit any type plant.
7. Simplicity in operation and control—no complicated mechanism.

Call or write for complete information on the new, easy-to-use Mechanical Pickler. Our trained engineers will be glad to advise you on such matters as pickling plant layout and design, pickle liquors, temperature control, ventilation, and selection of tanks.

Other WELDCO Pickling Products include Pickling Crates, Baskets, Chains, Hairpin Hooks, Jets, and Scrubbers. Catalogs available on request.

THE YOUNGSTOWN WELDING & ENGINEERING CO.
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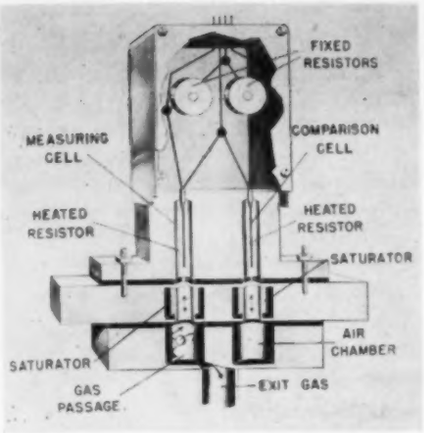


analysis has been accepted extensively in the process industries, because of its fast response to changes in gas composition, its freedom from chemicals, and its proven reliability. 3. Electronic type operation frees the instrument of the step action and delicate construction commonly found in galvanometer operated instruments ... also adds greater speed, power and magnification, while assuring high accuracy and permanency of calibration.

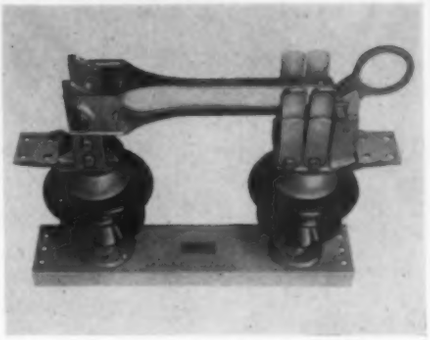
Gas to be analyzed flows through gas passage from which portion diffuses through saturator (where it is saturated to a constant water vapor dilution at 130 F) into measuring cell. As gas comes into cell it conducts heat from the heated resistor proportional to its thermal conductivity. Heat conducted away from the resistor changes its electrical resistance.

Simultaneously, air (similarly saturated) diffuses from air chamber into comparison cell. Air conducts heat away from heated resistor proportional to its thermal conductivity, thus changing its electrical resistance. This change in resistance is used as a constant reference.

Change in resistance of comparison cell resistor is compared with change in resistance of measuring cell resistor in bridge circuit of analyzer. Bridge circuit is connected into network of recorder where resultant resistance measurement is amplified, indicated and recorded.

OUTDOOR SWITCHES

▲ Delta-Star Electric Co. recently announced a new line of "B-2K" outdoor hook operated disconnecting switches. These switches are said to incorporate many of the outstanding features formerly found only in group



operated switches. These features include: high pressure silver to copper contacts, a new hard drawn copper tubular blade, and an overall design providing superior electrical and mechanical characteristics.

A new blade pryout and lock are incorporated to insure smooth, positive operation under all conditions. At the clip end contact is made by the blade operating against silvered copper hinge bars. Phosphor bronze spring cup washers maintain constant pressure on the silvered bars.

The switch is available in all standard voltage ratings from 7.5 to 161 kv and in ampere ratings of 600 and 1200 amperes, for upright, inverted or vertical mounting.

Announcing the New LESLIE MADE DOUBLE SEATED DIAPHRAGM VALVES
— for use with CONTROL INSTRUMENTS

Offering these Important Features:

★ "FLOW-LINE" CONTOURED BODY—provides high capacity at low pressure drop.
★ STANDARD ISA FACE-TO-FACE DIMENSIONS
★ STELLITED SEATING SURFACES
★ RENEWABLE SELF-ALIGNING GUIDES
★ POWERFUL, COMPACT FRICTION FREE DIAPHRAGM SUPERSTRUCTURE
★ THROUGH-BOLT CONSTRUCTION ON STEEL VALVES
★ WIDE RANGEABILITY
★ SEAT RINGS EASILY REPLACED WITH VALVE IN PIPELINE—not necessary to set up in a lathe or grind in at high temperature.

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WRITE FOR Bulletin 513

Available with various size superstructures. Sizes 1½" to 10" in Cast Steel and Cast Iron.

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SAFETY Thru Visibility In your plant or on your roadways is important. Well planned lighting is the answer.

Revere ELECTRIC MFG. CO. CHICAGO, ILL.
LIGHTING PUTS EVERY FOOTCANDLE TO WORK!

WE SPECIALIZE IN OUTDOOR and INDOOR LIGHTING FOR INDUSTRIAL PLANTS

LIGHT UP YOUR DRIVEWAYS, Shipping and receiving zones, entrances and parking lots for better safety and greater efficiency. REVERE has the units to meet all requirements. We can give you a completely modern system at moderate cost.

AREA LIGHT for GATES
FULL LINE OF ENCLOSED FLOODS
ELIMINATE RISKY CLIMBING
SEARCH LIGHTS
300 to 1500 Watt FLIPTOR FLOODS
AREA and SPOT LIGHTER
HINGED FLOOD POLES
PYLON-LITES

Put your Lighting Problem in the Hands of REVERE.

REVERE ELECTRIC MFG. CO.
6036 Broadway • Chicago 40, Ill.

WIRE ROPE LUBRICANT

▲ A new wire rope lubricant, Texaco "Crater A," which because of its unusual penetration and adhesion properties will permit application to wet wire rope has been marketed by Texas Co. after extensive highly satisfactory field tests.

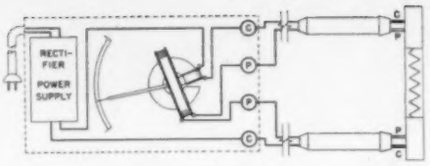
The new product, according to the company, represents an important improvement over the product previously marketed under the same name. The new formulation achieves greatly improved wettability while retaining all the desirable characteristics of previous lubricants of this type.

Field tests on cables in use on dredges and cranes returned performance data indicating that the compound is especially valuable for use in severe weather conditions, where the wire rope is wet when the lubricant is applied, or where cable is subjected to abnormal water conditions in use. The lubricant will penetrate and adhere to dripping wet wire rope.

It is a thin liquid product which is applied without heating. The new product remains pliable under a wide range of atmospheric conditions. It will not drip or evaporate in hot weather. In cold weather it does not harden or chip.

MEASURING INSTRUMENTS

▲ This most recent addition to the "Megger" family of electrical resistance measuring instruments was designed for maximum convenience in field use. The set, manufactured by James G. Biddle Co., is completely self contained with a compartment for storing leads and hand spikes. It is supplied in two models, both having the same ranges of 0 to 1000 and 0 to 10,000 microhms.



Schematic diagram of electrical connections for this new low resistance ohmmeter.

Model 1 B is a battery-powered set which employs two dry cells. Model 1 R has a built-in rectifier which can be plugged in to any ordinary lighting circuit outlet.

The complete units, with batteries or rectifier, weigh only about 19 lb and are therefore easily portable and convenient to use, providing facility for both field and bench tests.

The ranges of the instrument cover a wide variety of applications, such as routine tests on circuit-breaker contacts, relays, switches, bonds, connections and joints, and bar-to-bar tests on commutator type armatures. The ruggedness, compactness, and de-

This new FREE booklet tells how two new types of Oakite-developed solvent detergents make it easier and cheaper for you to do many difficult metal-cleaning jobs. Here are some of the subjects covered in the booklet:

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pendability of the set make it particularly applicable to power system and railroad use. No special training or experience is required to operate it.

PACKAGING PAPER

▲ Development of a new heavy-duty packaging paper, treated with a volatile type rust inhibitor was announced by the Nox-Rust Chemical Corp. The new product was developed for protection of heavy machinery and bulky metal parts during storage and shipping. It is made for Nox-Rust by Glas-Kraft, Inc.

The paper, called vapor wrapper, is tough, resilient, and tear-resistant. It is made of two high-strength kraft sheets, cemented together, and reinforced with spun glass fibers.

Identified as Nox-Rust No. 120 Glas-Kraft grade, it is one of a series of papers the company produces. The inner ply of kraft paper is impregnated with Callex, a volatile rust-inhibitor chemical. When a metal product is wrapped or shrouded with the wrapper, a vapor is released which prevents rust from forming. This product is also moisture and water repellent.

BETA GAUGES

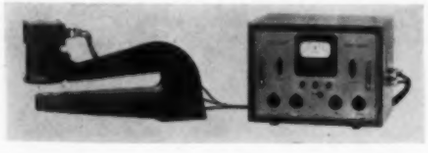
▲ Two new model absorption and backscatter beta gages for the low cost determination of the weight per unit area of sheet materials have been developed by Tracerlab, Inc.

Based on experience gained from a number of gages now in successful use in several process industries, the new gages incorporate improvements making them more suited to industrial use.

Absorption beta gages, basically, determine weight changes in sheet material—paper, plastics, rubber, thin metal sheets—by means of a small beam of beta rays. These rays, actually high energy electrons, are emitted from a sealed radioactive source and pass through the sheet to be measured.

A beta gage, in effect, weighs a small area of the moving sheet by means of a beam of radiation. If the density of the material is maintained constant, the meter can be calibrated in units of thickness, thus making the gage a sensitive thickness control instrument.

Beta gages are unaffected by speed of the moving web, do not contact the material being gaged, may be installed in any location on the machine, and the meters or recorders may be placed at a distance. Beta gages measure extremely thin materials impossible to gage by other methods and measure more types of materials because only weight per unit area is the controlling factor.



Tracerlab backscatter beta gages offer advantages for many installations because they are mounted on one side of the sheet only. Backscatter gages use the same console and recording apparatus as absorption types, but work on a slightly different principle.

SPEED REDUCER

▲ Shown in the illustration is the largest standard enclosed worm gear

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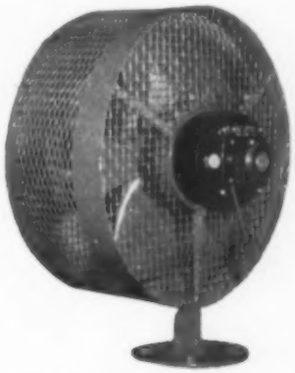

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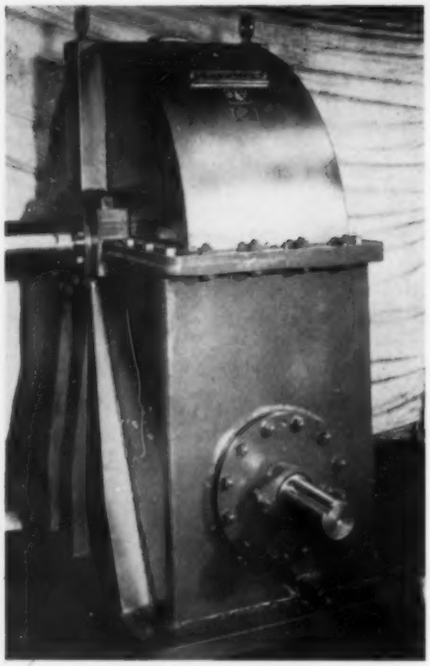

speed reducer ever built by De Lavel Steam Turbine Co.

It is a 30 in. center distance unit transmitting 200 hp at 410 rpm with a ratio of 17—to 1. It will soon go in service on a Mesta slabbing mill installation in a major steel company.

A second unit of the same size is currently being built for Mesta for a similar installation in another mill.

HEAD GRINDER

▲ A totally new conception and approach to the problems of face grinding is offered in the Mercury series E-20 traveling head grinder, as designed, developed and built by Mercury Engineering Corp.

Designed for the grinding of armor plate, it offers new opportunities in grinding edges, angular surfaces, compounds and bevels, as well as machining pads on heavy castings 20 ft or longer.

Because of the unique factors, the new design eliminates completely the expensive and hard-to-maintain traverse bed common to conventional traveling head grinders. Both initial and maintenance cost are reduced to a new low.

This revolutionary grinder runs on self-powered precision rollers along rails machined to precision tolerances and equipped with built-in leveling devices. The unit, employing a 20 in. face-type grinding wheel mounted on a head which tilts from horizontal to full vertical, has complete mobility with traverse rate continuously variable. Two or more grinders can operate simultaneously on a single set of rails. These rails being mounted on a simple concrete base are kept clean by means of an efficient wiper system.

Super powered for continuous production, the 20 hp motor and heavy duty precision spindle assembly are mounted within rigid trunnions and arranged to feed in and out through 7 in. range, utilizing planetary gear driven motor reducer in combination with precision lead screw. Various increments of feed are accomplished electrically.

Mercury Engineering Corp., designers and builders of precision machinery for the past sixteen years, announces that in addition to the new grinder a full range of heavy duty grinders are now in construction, powered up to 40 hp with geared head drive and employing 30 in. grinding wheels.

EMULSION CLEANER

▲ DuBois Co. announces its new, ready-to-use emulsion cleaner, "Super-Mul." The new cleaner is a high strength, active solvent emulsion cleaner specifically designed for the removal of industrial soils in spray washing machines. It cleans thoroughly, rinses freely, resists hard water, does not sludge out even with heavy soil loads.

Book Reviews

▲ **"Characteristic Figures on Power, Energy and Heat Consumption of Industry"** by W. Scholl, was recently issued in cooperation with W. Mackenthun and H. Masukowitz. It is published by the Association of German Power Companies, Frankfurt on Main. This book, consisting of almost 400 pages of lithographed material, is composed of two parts.

In the text proper the different industries are treated. For each industry, power consumption figures are shown, and, wherever heat is involved, heat consumption figures are given. In addition, in many instances total production figures for Germany are shown, sometimes in historical arrangement, going back as far as 1913 and being brought up to date to 1949 or 1950. In many instances the power consumption is broken down into the figures for each individual consuming unit.

The compilation is meant as an aid to power sales engineers. The publishers also state that this book is not meant to be final but that it will be gradually improved. It consists essentially of notes out of the files of the senior author. The information is concentrated, of course, mainly on German industrial practice, but in a few instances American figures are also shown. The book will have its main value either for those who are working for the European market or for those who want to compare American figures with European ones.

Of the total of 346 pages of text, 122 deal with metallurgical industries and of these 122 pages, 96 cover the iron and steel industry. The table of contents covers 44 pp. The bibliography of 17 pages, broken down according to industry, completes the volume.

▲ **"Corrosion Guide"** by Erich Rabold has been recently published by the Elsevier Press, 402 Lovett Boulevard, Houston, Tex., 6¼ × 9½ in., 629 pp, cloth bound, price $12.50. Whenever new processes are developed or new manufacturing operations set up, the question often comes up as to what can be used to minimize corrosion. Most books concern themselves with the fundamental theories on corrosion behavior. This book consists primarily of tables which cover the action between important construction materials and more than 250 corrosive agents. It thus enables a solution of almost any corrosion problem without any loss in time.

▲ A revised edition of the **"American Standard for Screw Thread Gages and Gaging"** has just been approved by the American Standards Association, 70 East 45th Street, New York 17, N. Y., price $4.00. This edition brings up-to-date the methods for checking threaded products to see if they comply with the requirements for Unified and American Screw Threads for Screws, Bolts, Nuts and Other Threaded Parts, B1.1-1949. The Unified Threads were approved in 1949 by Great Britain, Canada, and the United States.

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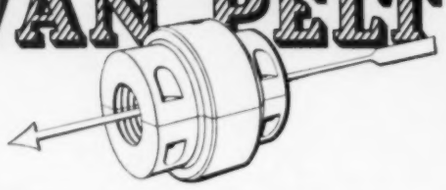

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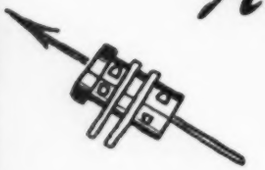

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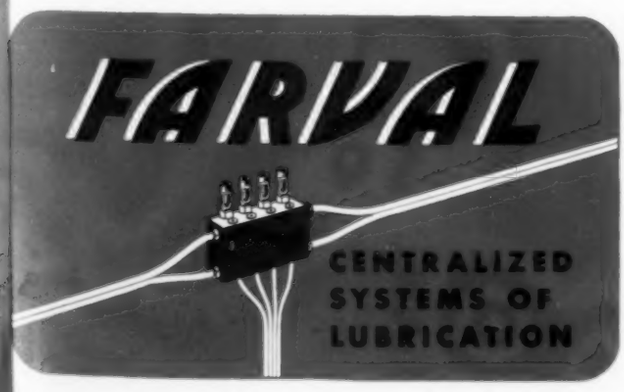

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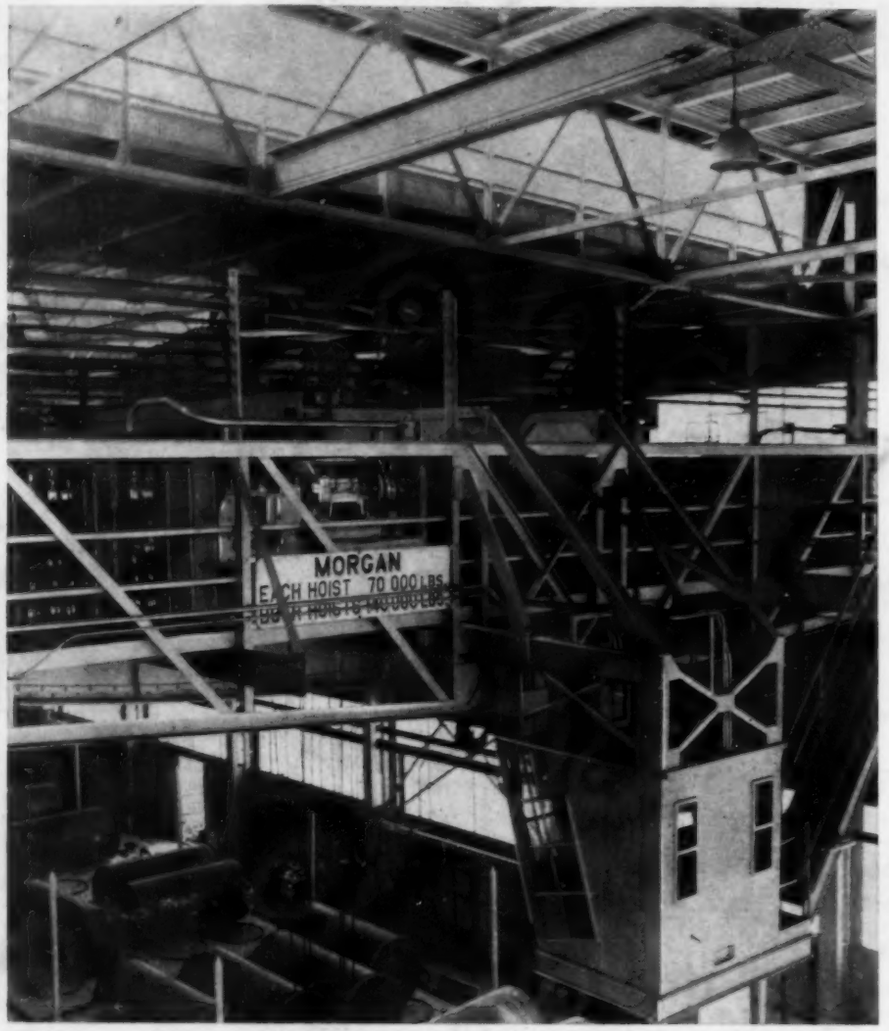

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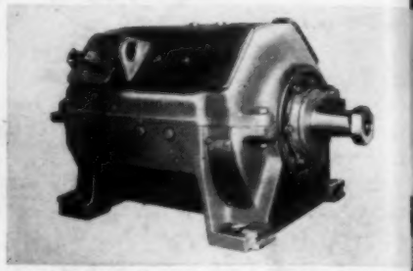

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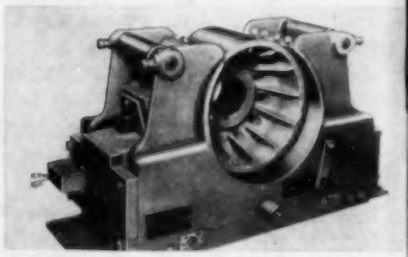

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DRIVES

Here's the kind of success story that's making General Electric crane control a heavy steel-mill favorite. In the box annealing building at this large mill, a 10-ton auxiliary hook on a mill crane was handling stacks of steel sheets to be put into annealing furnaces. Because the crane was frequently overloaded, two to four motor breakdowns a year had occurred over an eight-year period.

A G-E hoist control panel was installed in place of the previous magnetic control, providing safe and stable full-speed lowering operation for heavy overloads. Result: Motor breakdowns were cut to zero during the next 20-month period before the crane was retired from this severe duty. Furthermore, motor maintenance had been reduced by the lower commutating peaks and improved automatic deceleration. So impressed were the mill's operators by this outstanding performance that they selected G-E crane control, plus G-E MD-600 crane motors, for seven new crane installations (one shown above).

Is *yours* a tough crane drive problem? General Electric—with over 40 years of experience in working with crane builders—can help you solve it. Ask your G-E steel-mill specialist about it; meanwhile send for Bulletin GEA-5408 on G-E d-c crane drives. *General Electric Company, Schenectady 5, N. Y.*

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